THE

GOLD-SEEKER'S MANUAL.

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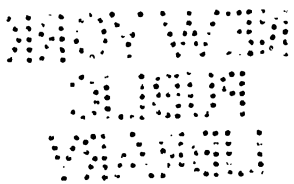

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INTRODUCTORY REMARKS.

THE occurrence of gold in large quantities in a district hitherto little visited by civilized man, and only known by the accounts of a few travellers, has naturally produced great excitement in the public mind and much anxiety as to the possible results.

It has seemed to the author that some account of the general distribution of gold in the world, of the statistics of gold generally, and of the physical peculiarities of that new country to which all eyes are now turned, together with a short and popular, but practical, statement concerning the mode of treatment of this valuable metal, will probably be found interesting to the public at large, and cannot fail to be useful to those who have it in contemplation to journey in search of the mineral

riches so temptingly offered to the adventurer. It is proposed in the present manual to give an account, first, of the chief districts in which gold has hitherto been found, including California itself; to explain then the way in which the metal usually occurs in nature, and the modes by which it may be certainly distinguished from other substances resembling it; to describe afterwards the modes which have been generally adopted to separate the metal from associated stones and earths, and reduce it to a convenient form for transport; and lastly, to discuss the highly important question of the probability of permanence in the supply thus commenced, and the result such an influx must produce on the value of gold in the various markets of the world. I shall not waste the time of the reader by any general remarks not strictly belonging to the subject, but endeavour in every way to render this little work a practical manual that may be useful to the emigrant and instructive to those who may be inclined to join in the speculations that will no doubt be set on foot immediately in this country and America.

CHAPTER I.

ON THE GENERAL DISTRIBUTION OF GOLD.

Of all metals, gold is, with the exception of iron, the most widely distributed over the earth; but it differs from the latter metal in being present usually in a nearly pure state, but in exceedingly small quantities, whereas iron is abundant as well as generally diffused, and is never found unmixed with other substances. Owing to the very minute proportion in which gold is often associated with rocks and mineral substances, it does not generally pay the cost of working; and the districts therefore known as *auriferous* or "gold-producing," in the commercial sense of the term, are not so numerous as the foregoing remarks might seem to suggest. Nearly all the gold of commerce has for a long time been obtained from Asiatic Russia, Brazil, Transylvania, Africa, the East Indian islands, and Carolina in the United States; the whole annual supply being estimated at about 80,000 pounds weight, and its value being about five millions sterling. This however must be regarded as only an approximate value of the average of several years, as the supplies have for some time been increasing rapidly from the Russian mines.

We will now consider a little in detail the districts above-mentioned; first of all saying a few words on the reports of valuable gold-mines in the British Islands.

These refer chiefly to Wales and Ireland, but include the stream works of Cornwall and the alluvial soil in the mining field of Lead-hills in Scotland. In the time of Queen Elizabeth, extensive washings were carried on in the latter district for the purpose of collecting this precious metal. It also occurs in Glen Turret in Perthshire, and Cumberhead in Lanarkshire. Of late years serious attempts have been made to commence workings on a large scale in North Wales, where quartz veins containing gold have been long known to exist. Although from time to time lumps and small accumulations of the precious metal have been found in all the spots above mentioned, and even in many others, there has nowhere been any regular prospect of success from continued working, except in the county Wicklow in Ireland.

Towards the close of the last century native gold was accidentally found to occur disseminated in the bed of the streams which descend from the northern flank of Croghan Kinshela, a mountain which lies on the confines of Wicklow and Wexford, and at the junction of the granitic ridge

with the clay-slate. Considerable quantities of gold were collected by the people. It occurred in massive lumps, and in small pieces down to the minutest grain. One piece weighed twenty-two ounces, another eighteen ounces, others nine and seven ounces. The gold was found accompanied by other metallic substances, dispersed through a kind of stratum composed of clay, sand, gravel, and fragments of rock, and covered by soil which sometimes attained a very considerable depth (from twenty to fifty feet) in the bed and banks of the different streams. Shortly after the discovery of the occurrence of gold, the business of its extraction was taken up by the government, under the management of Mr. Weaver and some others.

The total quantity of gold collected by the government workings in about two years was 945 ounces, which was sold for £3675; but the cost of the workings and of various trials made in search of the original deposit of the gold exceeded this return, and the workings having been interrupted, were not again resumed by government. It has been calculated that at least £10,000 was paid to the country-people for gold, collected before the government took possession of the works.

This native gold is of a rich yellow colour, soft and malleable. Its specific gravity is 19. An assay

of 24 grains of it effected by Mr. Weaver, gave pure gold 22·58 and silver 1·43. Another assay of it by Mr. Alchorn, Assay Master in London, gave, for 24 grains, $21\frac{6}{8}$ fine gold, $1\frac{7}{8}$ silver, and three-eighths of a grain of an alloy of copper and iron.

The localities that have yielded gold in the largest quantity are Ballinvally, Ballintemple, and Killahurler, all situated in the same valley. The gold is associated with magnetic ironstone, sometimes in masses of half a hundredweight; also iron pyrites, brown and red hematite, wolfram, manganese, and fragments of tinstone in crystals, together with quartz. From the nature of these attendant minerals, of which most are known to occur in the quartz veins of the adjacent mountain, it was hoped, that by tracing up the rivulets to their sources, and laying bare in various directions the underlying rock, the metalliferous veins might be discovered, from the disintegration of which the sand and soil of the bed of the streams had been produced. All such trials proved useless, and the question as to the source from whence the gold of those streams in Wicklow has been derived, remains still unanswered*.

The gold-mines at present most productive are those of Russia, and chiefly Siberia. They extend first on the eastern flanks of the Ural in

* Kane's Industrial Resources, "Ireland," p. 219.

a zone running north and south of the town of Ekaterinburg through five or six degrees of latitude; secondly, in the governments of Tomsk and Yeneseik, where low ridges run northwards from the great chain of the Altai mountains, and where, over an area larger than the whole of France, not only are considerable quantities of gold found mingled with sand and gravel on the surface, but even the rocks themselves when pounded up are found to afford a per-centage of that valuable metal.

Of the former of these districts, the mines of Berezovsk near Ekaterinburg have been the most productive, and yielded during the century previous to 1841, about 24,500 lbs. avoirdupois weight of gold (worth a million and a half sterling), obtained from something less than a million of tons of ore stuff. In general the matrix consists of coarse gravel, not unlike that found near Woolwich; but there are also true auriferous veins inclosed in a band of rock, in which are many veins of quartz with gold disseminated. From these veins the valuable portions are extracted by vertical shafts and lateral galleries; and it is worthy of remark, that this is the only instance in the whole Russian territory where gold is extracted by the aid of subterranean workings.

Much more generally the gold is found in fragments of rock which cover the surface to a con-

siderable thickness, and the metal is obtained by processes which will be described in a future chapter. Associated with the gold are other metals, as platinum and palladium, and diamonds have also been found, though rarely, both here and at various points in the Ural chain.

The eastern district of gold-washings in Siberia includes in the whole three localities:—one between the valleys of the Obi and the Tom, the next between the Tom and the Yenesei, and the third, the most eastern, reaching from the Yenesei to the Lena.

In each of these the metal is disseminated in a quartzy sand or rather gravel rich in oxide of iron; but it seems to follow a particular mineral, since it occurs most abundantly either in veins of diorite, or in those valleys in which diorite appears. It is not the case however that the auriferous sands are confined to the valleys—they extend to the hill-summits, and are found capping the mountains even where these exhibit distinct escarpments.

Generally in the Russian alluvial deposits containing gold, the quartz pebbles and fragments are those which yield most considerably. Occasionally large lumps (*pepitas*) are found, especially in the mines south of Miask, where several weighing from thirteen to twenty pounds

have been found; and one lump was obtained in 1843, and is now at St. Petersburg, the weight of which is no less than seventy-eight pounds avoirdupois—its value therefore about £3000.

It is not however commonly the case in the Ural to find large lumps, the usual fragments being of small size, and only separated as in other gold-producing countries by washing—the washings seldom yielding more than thirty-six grains of gold per ton weight of soil, and never in ordinary cases more than seventy*.

The rocks in which the gold of the Ural mountains and Siberia is found are very variable in their nature, including granites, metamorphosed schists, and other igneous and altered rocks. Similar rocks re-appear in various parallels of longitude along the flanks of the Altai, and there can therefore be little doubt that the supply from this district, already so large, is not likely greatly to diminish. In China again, it is well known that large quantities of gold are obtained, and there is good reason to suppose that a pretty uniformly auriferous district extends across the whole of northern Asia.

* The sand of any river is worth washing for the gold it contains, provided it will yield twenty-four grains per hundredweight; but the sand of many streams yields many times this proportion.

The annual supply of gold from Russia is not only very large, but manifestly increasing. Returns of the quantity raised and paying duty, between the years 1830 and 1842, both inclusive, gave a grand total for that period of 222,156 pounds avoirdupois (worth thirteen and a half millions sterling); but of this quantity considerably more than one-third had been obtained in the last three years of the period, and more than a fourth in the last two years, while the last year's supply (that of 1842) was admitted to exceed 32,500 pounds avoirdupois, and probably amounted in all to not less than 40,000 pounds weight, worth nearly two and a half millions sterling. Returns however have been lately made to the House of Commons, by which it appears that gold to the value of four millions sterling has been annually raised in the years since 1842 to 1846; and Sir E. Baynes, the British Consul at St. Petersburg, from whom these returns are obtained, writes with reference to future prospects:—"It is said that new mines have been discovered in the Ural, and the fact of an imperial ukase having lately forbidden the sale of public estates in the region of the auriferous sands of Siberia, justifies the inference that the government have made successful surveys in that direction, and anticipate a further profitable development of the gold-washings which

have been so fruitful during the last four years. Under these circumstances it would seem reasonable to expect an increase of supply, of which however it is quite impossible to estimate either the proportion or the continuance."

Next in importance to the Russian dependencies in Asia and Europe, the mines of Brazil yield the largest quantity of gold, and have been most important since the discovery of America.

Gold is found in this country on both sides and for a very considerable distance at the foot of the immense chain of mountains running parallel with the coast, from the fifth to the thirtieth degree of south latitude. It is found more or less in almost all the rivers which form the upper branches of the Francesco, Tocantins, Araguay and Guaporé, but chiefly in the affluents of the Francesco.

The face of the country is uneven and rather mountainous. The rock, when exposed, appears to be primitive granite, inclining to gneiss, with a portion of hornblende and frequently mica. The soil is red and remarkably ferruginous, in many places apparently of great depth. The gold lies, for the most part, in a stratum of rounded pebbles and gravel called *cascalhao*, immediately incumbent on the solid rock. In the valleys, where there is water, occur frequent excavations made by the gold-washers to a considerable extent, some

of them 50 or 100 feet wide, and 18 or 20 feet deep. On many of the hills, where water can be collected for washing, particles of gold are found in the soil little deeper than the roots of the grass.

It is particularly near Villa Rica, in the environs of the village of Cocaes, that the most numerous washings are established; and here the *pepitas* or lumps and scales of gold occur, mingled with the sand of the rivers or the alluvial deposits on their banks. In the province of Minas Geraes the gold also occurs in veins as well as in the form of grains disseminated through the alluvial loams, but it is only in comparatively recent times that attempts have been made to work the mines in the mountains.

Before the beginning of the last century the quantity of gold obtained was inconsiderable, but it increased rapidly. The greatest quantity was found between 1753 and 1763, and since that time it has always been on the decrease. According to the incomplete accounts which Eschwege was able to obtain, he calculated that the whole quantity of gold collected between 1700 and 1820 amounted to a million and three-quarters pounds weight avoirdupois, or about 14,800 lbs. annually, including one-fifth which he thinks was smuggled out of the country. Between 1753 and 1763 it

amounted annually to about 16,000 lbs., but between 1801 and 1820 only to 3540 lbs. In the last two statements the gold smuggled out of the country is not included, and it may amount to more than one-fifth, at least for the latter period, when the means of communication had been greatly increased. The decrease of the produce was mainly owing to the better portion of the auriferous sand having been exhausted, and to the want of sufficient capital to work the veins in the mountains on a regular system. British capital has since been employed with success, and the productive mines at Gongo Soco, near the Villa de Sabarà, on the banks of the Rio das Velhas, a tributary of the Rio de St. Francesco, have been the reward of British enterprise.

Other parts of South America supply also gold to some extent, but that of Mexico and some other districts is mixed with silver or iron, and generally in the sulphurets of these metals, such mixtures, though exceedingly poor, sometimes repay the cost of extraction, as in the case of the silver of Guanaxuato, which contains only $\frac{1}{360}$th of its weight of gold.

Oaxaco contains the only auriferous veins worked as gold-mines in Mexico; they traverse rocks of gneiss and mica-slate.

All the rivers of the province of Caracas to 10° N. of the line, flow over golden sands.

Peru is not rich in gold ores. In the provinces of Huailas and Pataz this metal is mined in veins of quartz variegated with red ferruginous spots which traverse primitive rocks. The mines called Pacos de Oro consist of ores of iron and copper oxides containing a great quantity of gold. All the gold furnished by New Grenada (New Columbia) is the product of washings established in alluvial grounds. The gold exists in spangles and in grains, disseminated among fragments of greenstone and porphyry. At Choco, along with the gold and platinum, hyacinths, zircons and titanium occur.

The gold-washings of El Mineral de Veraguas in Central America, near the Caribbean coast, have been once very productive, and are still the most important in the Isthmus of Panama; these washings have been worked since the Spanish conquests. Towards the end of the last century some of the Spanish creoles obtained from the unexplored ravines, or rather from the bottom of gullies, which had been filled up by the accumulation of sands, upwards of 20 lbs. of gold weekly for some months, and lumps weighing many pounds. Even during the years 1800 and 1804 there were introduced into the provincial treasury from the

river Conception and its branches, 2067 lbs. to pay the 3 per cent., being 3 per cent. of the produce of these washings. Since then however, like many other gold-washings, the great deposits have been exhausted—the present washers are limited to the daily decomposition of the granitic mountains. It is not impossible but there may be still undiscovered filled-up ravines, the usual golden stores, which some fortunate individual may yet meet with in that neighbourhood. All the gold is in coarse grains, and of a high standard, and is produced by granite containing the brightest yellow mica.

The gold found in Europe at present out of Russia is not of sufficient importance to enter into any calculation of large results, except in one or two instances. The most important of these is Transylvania, although the sands of the Moldau and other rivers of Bohemia have long been known to contain some quantity. The annual supply from Hungary has been stated by M. de Villefosse to amount to 2810 pounds weight, the value being £176,000.

Amongst the gold districts of Europe, the valley of the Rhine between Basle and Mannheim is not the least remarkable; and a recent French writer, M. Daubrée, has even asserted that the richer auriferous zones may be attacked with profit.

The gravel most usually worked is that deposited at some distance below a sand-bank or gravel island which the current has eaten away, and which is the result of this abrasion. It is only in the middle of the larger gravel on the margin of the bank nearest the head of the stream, and rarely for a thickness of more than half an inch, that the gold is concentrated. The little flakes of gold are always accompanied by titaniferous iron, of which the quantity varies from 0·00002 to 0·0002, being always in proportion to the richness of the sand in gold.

Beyond the actual bed, gold also occurs in ancient deposits of the river, forming a zone of three miles in breadth; but no trace has been found either in the fine sand without flints daily deposited by the Rhine in its delta, or in the diluvial clay known under the name of *loess*.

The gold spangles are always exceedingly minute and thin, requiring from 11 to 1400 to make a grain troy, and one cubic yard containing from 5000 to 40,000 of these spangles; they appear to be derived from the crystalline schists and other rocks of the high Alps.

Compared with Siberia and South America, the auriferous gravel of the Rhine is exceedingly poor, the Siberian sands yielding five times, and those of Chili ten times, as much ore as that obtained

from the same quantity of the most productive sands of the Rhine.

The mines of Spain, anciently rich and valuable, are now neglected; and this is the case also with the sands of the Danube, the Rhone, the Tagus, and many other of the European rivers which possess gold in small quantities, but are rarely worth the expense of working. The sands are usually of black or red colour, and therefore ferruginous.

The gold obtained from Africa is chiefly found between Darfur and Abyssinia, and to the south of the great desert of Sahara from the mouth of the Senegal to the Cape of Palms; but a considerable quantity is also found opposite Madagascar on the Mozambique coast between lat. 25° and 22° south. Some of the same precious metal is found in the sands of the Gambia, the Senegal, and the Niger, and the Gold Coast near the equator has long yielded the traders to that part of the world large quantities of gold-dust. The whole supply from this continent is estimated at about 5000 lbs. weight avoirdupois (value £300,000 sterling).

The supply of gold from Asia is not confined to the plains of Siberia, since the rivers of Lydia and other parts of Asia Minor, the numerous islands in the Indian Ocean, and the peninsula of Hindostan, have supplied very large quantities. This

is also the case with regard to the kingdom of Siam, part of the Chinese empire, and a wide tract in Cochin China. As much as a thousand pounds weight are collected annually in Sumatra, and probably a very large quantity from the other localities mentioned.

The mines of the United States of North America producing gold range along the Appalachian chain, particularly on the eastern slope from Maine to Alabama, having nearly a north-east and south-west course; they are mostly confined to the states of Virginia, North and South Carolina and Georgia, but extend also to Canada. Of these the Carolina and Georgia mines are the most important, and have yielded masses of gold of considerable size, one having been found weighing 28 lbs. avoirdupois. The average annual quantity for the last three years is something less than 3000 lbs. weight (value £175,000).

CHAPTER II.

THE GOLD DISTRICT OF CALIFORNIA.

We now come to the remarkable discovery of large quantities of gold in California. This country, situated in the western part of North America on the shores of the Pacific Ocean, and forming till lately the north-west portion of the united states of Mexico, consists of two parts,—the narrow peninsula of Old California, divided from the main land by the Gulf of California and extending from Cape St. Lucas to about 32° N. lat., and New or Upper California, ceded to the United States by a recent treaty, comprehending the whole country from 32° to 42½° north latitude, where it borders on the Oregon territory. The gold district, as is at present known, is in the northern part of New California, commencing near the mouth of the Sacramento river in lat. 39° north and long. 122½° west, about 100 miles north-east from the Bay of San Francisco, and extending up the main valley northwards and into several side valleys on the east.

In order to give a correct idea of the general nature of this district and the circumstances under

which the gold occurs, it will be necessary to say a few words with regard to the physical geography of the surrounding country. Little is known generally of the interior, and even the boundary-line of California to the east is hardly determined, but along the coast there are several settlements of missionaries in narrow transverse valleys enclosed by steep mountains, which are separated from the coast by a broad tract covered with low sand-hills. The mountains just alluded to (the coast range) are rocky and barren; they range north-west in distinct chains, and as they advance northwards decline in height towards the bay and port of San Francisco, but still further north are continued in high land diverging to the east. Another mountain-chain, the Sierra of San Marcos of Humboldt, called in recent maps the Sierra Nevada or Snowy range, ranges also parallel with the coast at a distance of about 160 English miles, leaving an intervening valley (the valley of the Tule lakes) from 40 to about 60 miles wide. The whole breadth thus known measures about 120 to 150 miles, and is bounded to the east by a sandy desert reaching to the foot of the mountain-chain which forms the western boundary of the valley of the Colorado.

The mountain masses which constitute the peninsula of Lower California extend undivided as

far north as 34° N. lat. to the snow-capped peak of San Bernardino, whose height has not yet been determined. North of this summit the mountains divide into the two principal ranges just described, which include between them the extensive valley of the Tule lakes. The chain which runs on the north-east of the valley and divides it from the great desert, rises to a considerable height, much of it being covered with snow all the year round, which between 36° and 37° N. lat. on this coast implies an elevation of about 10,000 feet above the level of the sea. The range which extends on the western side of the valley of the Tule lakes and divides it from the sea has its principal chain close to the valley, but several ridges branch off from it to the west, and thus form a number of longitudinal valleys which are generally of very moderate width. The most remarkable is that ridge which branches off near San Ines (35° N. lat.) and separates the Rio Buenaventura or the Monterey river from the coast. The mountains on the south-west of the Tule lakes terminate at the south-east extremity of the bay of San Francisco.

The two Tule lakes occupy a considerable portion of the valley, extending about 100 miles in length, but their width is variable. At the end of the dry season they have so little water

that they are fordable at several places. Shortly after the rains, and whenever the snow on the adjacent mountains is melting, these lakes discharge a considerable volume of water by the river San Joaquin which falls into the south-east corner of the bay of San Francisco; but after the vernal equinox, the quantity of water thus discharged is very inconsiderable. The mountains which enclose the valley on the south-west seem to advance close to the banks of the lakes, but those on the north-east are at some distance, so that a tract of level or undulating land lies between them. This tract seems to be fertile, but is not yet cultivated, no agricultural establishment having been formed here.

The only settled part lies along the coast, the missions being nearly all within one day's journey from it. The settlements are not extensive; the valleys being in general narrow, and the mountains which enclose them too steep to be cultivated, though they supply pasture for a considerable part of the year.

The country about the bay of S. Francisco seems to be the best portion of Upper California. The soil is doubtless inferior to that of the valleys further to the south, but the cultivable land occupies a much greater extent along the banks of the three rivers S. Joaquin, Jesus Maria, and Rio

Sacramento, which fall into the bay. The settlements in this part are not yet numerous, but have now become of vast importance as they are near the gold region.

Upper California partakes more of a cold than of a warm climate. The rainy season is from November to February. The rain is abundant in the northern districts, but decreases in quantity farther south; and at San Diego, the southernmost of the missions, probably no rain at all falls, as in the north of Lower California. The winter is much milder than in the same latitude on the east coast of America, for it does not appear that the Tule lakes are ever covered with ice, nor is frost frequent in the valleys, though the surrounding heights are covered with snow for a few months. The summer is very dry, no rain falling then, except at Monterey, where there are sometimes, but rarely, slight showers. The heat is great, and the thermometer probably rises to 80° and more; but exact observations are wanting. On the banks of the Rio Colorado, at the extremity of the sandy desert, Dr. Coulter observed the thermometer rise to 140° in the open air.

The greater part of New California appears to be covered with rocky mountains containing a very small proportion of arable land, but where the soil is arable it is usually rich. Black cattle

form the principal article of produce, and though brought to California not a century ago, the number now amounts to not less than 300,000; about 60,000 are annually killed and the hides salted and exported. Sheep are also numerous, but horses and mules are reared only so far as is requisite for consumption.

The population of Upper California is not very great; the number of whites is estimated by Dr. Coulter at about 6000, and the native Indian population may perhaps amount to 20,000. In the time of the Spaniards there were a few military establishments intended to protect the missions, of which there were about twenty, in a languid state. The chief places are San Diego, with a good but not deep harbour; Monterey, on a large bay having good anchorage; and San Francisco on the bay of that name, which is very spacious, extending upwards of sixty miles from N.E. to S.W., with an average breadth of about twenty miles; the latter is likely to be by far the most important settlement in reference to the present operations of gold-seeking.

The soil of New California near the coast is described by Humboldt as being well-watered and fertile, and the country as one of the most picturesque that can be seen. The sky is foggy, but the frequent fogs which render it difficult to land

at Monterey and San Francisco give vigour to vegetation and fertilize the soil, which is covered with a black and spongy earth. Wheat, maize and haricots (*frisoles* of the Spanish) are cultivated in abundance, while barley, beans and lentils grow very well in the fields in the greatest part of the province. Good wine is made along the coast within 150 miles of San Francisco, and the olive is cultivated a little farther south. Cold winds blow with impetuosity from the north and north-west, sometimes preventing the ripening of the fruits, but a little inland in sheltered places there appears no check to vegetation.

The natives of this part of the American coast are described as being a quiet and even industrious race, those settled in the villages being employed in spinning coarse woollen stuffs. But their principal occupation up to a recent period, and one of which the produce might become a very considerable branch of commerce, is the dressing of stag skins. It will probably be considered not uninteresting to relate here the information collected by Humboldt, from the manuscript journals of Colonel Costanzo, relative to the animals which live in the mountains between San Diego and Monterey, and the particular address with which the Indians get possession of the stags.

In the cordillera of small elevation which runs

along the coast, as well as in the neighbouring savannahs, there are neither buffalos nor elks; and on the crest of the mountains which are covered with snow in the month of November, the *berendos* with small chamois horns, feed by themselves. But all the forest and all the plains covered with grass are filled with flocks of stags of a most gigantic size, the branches of which are round and extremely large. Forty or fifty of them are frequently seen at a time; they are of a brown colour, smooth and without spot. Their branches, of which the seats of the antlers are not flat, are nearly $4\frac{1}{2}$ feet in length. It is affirmed by every traveller, that this great stag of New California is one of the most beautiful animals of Spanish America. It probably differs from the elk of the United States, of which naturalists have very improperly made two species. These stags of New California, not to be found in Old California, formerly struck the navigator Sebastian Biscayno, when he put into the port of Monterey on the 15th December, 1602. He asserts that he saw some of which the branches were nine feet in length. He describes them as running with extraordinary rapidity, throwing their head back, and supporting their branches on their backs. The horses of New Biscay, which are famed for running, are incapable of keeping up with them;

and they only reach them at the moment when the animal, who very seldom drinks, comes to quench his thirst. He is then too heavy to display all the energy of his muscular force, and is easily come up with. The hunter who pursues him gets the better of him by means of a noose, in the same way as they manage wild horses and cattle in the Spanish colonies. The Indians make use, however, of another very ingenious artifice to approach the stags and kill them. They cut off the head of a *venado*, the branches of which are very long; and they empty the neck, and place it on their own head. Masked in this manner, but armed also with bows and arrows, they conceal themselves in the brushwood, or among the high and thick herbage. By imitating the motion of a stag when it feeds, they draw round them the flock which becomes the victim of the deception. This extraordinary hunt was seen by M. Costanzo, on the coast of the channel of Santa Barbara, and it was seen twenty-four years afterwards in the savannahs in the neighbourhood of Monterey, by the officers embarked in the galetas Sutil and Mexicana. The enormous stag branches which Montezuma displayed as objects of curiosity to the companions of Cortez belonged, perhaps, to the *venados* of New California. I saw two of them which were found in the old monument of

Xoachicalco, still preserved in the palace of the viceroy. Notwithstanding the want of interior communication in the 15th century in the kingdom of Anahuac, it would not have been extraordinary if these stags had come from hand to hand from the 35th to the 20th degree of latitude, in the same manner as we see the beautiful *piedras de Mahagua* of Brazil among the Caribs, near the mouth of the Orinoco*.

It is owing to the peculiar structure of the country described in the foregoing pages, and the existence of a lofty range of snow mountains, rising singly like pyramids from heavily-timbered but very lofty plateaux, to the height of 14,000 and even 17,000 feet above the sea, that the climate, soil and productions on the two sides of this range are so different, that while one is eminently mild, fertile and favourable to vegetation, the other is barren and cold. The following observations recorded by Col. Fremont will be found interesting with reference to this subject.

"The two sides of the Sierra exhibit two distinct climates. The state of vegetation, in connection with some thermometrical observations made during the recent exploring expedition to California, will establish and illustrate this difference. In

* Humboldt's Political Essay, vol. ii. p. 350 (English translation).

the beginning of December 1845, we crossed this Sierra at about 39° N. lat., at the present usual emigrant pass, at the head of the Salmon Trout River, forty miles north of New Helvetia, and made observations at each base and in the same latitude to determine the respective temperatures; the two bases being respectively, the western about 500, and the eastern about 4000 feet above the level of the sea; and the pass 7200 feet. The mean results of the observations were, on the eastern side at sunrise 9°, at noon 44°, at sun-set 30°; the state of vegetation and the appearance of the country being at the same time (second week of December) that of confirmed winter, the rivers frozen over, snow on the ridges, annual plants dead, grass dry, and deciduous trees stripped of their foliage. At the western base, the mean temperature during a corresponding week was, at sunrise 29°, and at sunset 52°; the state of the atmosphere and of vegetation, that of advancing spring; grass fresh and green four to eight inches high, vernal plants in bloom, the air soft, and all the streams free from ice. Thus December on one side of the mountain was winter, on the other it was spring."

The above account from Colonel Fremont's Report to Congress gives a striking and interesting example of the peculiarities of climate in the di-

strict, and the result is seen in the perfection of growth and great variety of the natural vegetable products in one part, while another exhibits a surface of almost absolute sterility.

It will now be understood that the existence of a warm and sheltered valley between two mountain chains forms a peculiar feature of this part of California, and it is a most fortunate occurrence that the gold region appears to be within its range. We must therefore describe it a little more in detail, and cannot do this from better authority than that of Col. Fremont, quoting once more from his memoir addressed to the last meeting of the Congress of the United States.

He says, speaking of the intervening space between the Sierra Nevada and the coast range, "North and south, this region embraces about 10° of latitude—from the peninsula of California to the Oregon. From east to west it extends from the Sierra Nevada to the sea, averaging in the middle parts 150 miles, in the northern parts 200, giving an area of above 100,000 square miles. Looking westward from the summit of the Sierra, the main feature presented is the long, low, broad valley of the Joaquin and Sacramento rivers; the two valleys forming, in fact, one, which is 500 miles long and 50 broad, lying along the base of the Sierra, and bounded to the west by the low

coast range of mountains which separates it from the sea. Long dark lines of timber indicate the streams, and bright spots mark the intervening plains. Lateral ranges, parallel to the Sierra Nevada and the coast, complete the structure of the country and break it into a surface of valleys and mountains—the valleys a few hundred, and the mountains two to four thousand feet above the sea. These form greater masses and become more elevated in the north, where some peaks, as the Shasti, enter the regions of perpetual snow. Stretched along the mild coast of the Pacific, with a general elevation in its plains and valleys of only a few hundred feet above the level of the sea, and backed by the long and lofty wall of the Sierra, mildness and geniality may be assumed as the characteristics of its climate. The inhabitant of corresponding latitudes on the Atlantic side of the continent can with difficulty imagine the soft air and southern productions under the same latitudes in the maritime region of Upper California. The singular beauty and purity of the sky in the south of this region is characterized by Humboldt as a rare phænomenon, and all travellers realise the truth of his description.

"These two valleys of the Sacramento and San Joaquin are discriminated only by the names of the rivers which traverse them. The valley of the

San Joaquin is about 300 miles long and 60 broad, between the slopes of the coast mountain and the Sierra Nevada, with a general elevation of only a few hundred feet above the level of the sea. It presents a variety of soil, from dry and unproductive to well-watered and luxuriantly fertile. The eastern (which is the fertile side of the valley) is intersected with numerous streams forming large and very beautiful bottoms of fertile land, wooded principally with white oaks in open groves of handsome trees, often five or six feet in diameter, and 60 to 80 feet high. The larger streams, which are 50 to 150 yards wide, and drain the upper parts of the mountains, pass entirely across the valley, forming the Tule lakes and the San Joaquin river, which, in the rainy season, make a continuous stream from the head of the valley to the bay. The foot hills of the Sierra Nevada which limit the valley make a woodland country diversified with undulating grounds and pretty valleys, and watered with numerous small streams, which reach only a few miles beyond the hills, the springs which supply them not being copious enough to carry them across the plains. These afford many advantageous spots for farms, making sometimes large bottoms of rich moist land. The rolling surface of the hills presents sunny exposures sheltered from the winds, and

having a highly favourable climate and suitable soil, are considered to be well-adapted to the cultivation of the grape, and will probably become the principal vine-growing region of California. The uplands bordering the valleys of the large streams are usually wooded with evergreen oaks, and the intervening plains are timbered with groves or belts of evergreen and white oaks among prairie and open land. The surface of the valley consists of level plains along the Tule lakes and San Joaquin river, changing into undulating and rolling ground nearer the foot hills of the mountains.

"The northern half of the valley of Upper California is watered by the Sacramento, which runs down south into the bay of San Francisco, while the San Joaquin comes into it from the southern extremity, flowing northwards and meeting the Sacramento in the bay, which is nearly in the middle of the valley." It is in this northern part of the valley that the gold has hitherto been found.

"The valley of the Sacramento is divided into an upper and lower part, the lower being 200 miles long, the upper about 100. The latter is not merely entitled to the distinction of upper as being higher up on the river, but also as having a superior elevation of some thousands of feet above it. The division is strongly and geographically

marked. The Shasti peak stands at the head of the lower valley in the forks of the river, rising from a base of about 1000 feet, out of a forest of heavy timber. It ascends like an immense column upwards of 14,000 feet (nearly the height of Mont Blanc), the summit glistening with snow, and visible from favourable points of view at a distance of 140 miles down the valley. The river here, in descending from the upper valley, plunges down through a *canon* falling 2000 feet in 20 miles. The upper valley trends to the north-east. It is 100 miles long, and heavily timbered; and the climate and productions are modified by its altitude, its more northern position, and the proximity and elevation of the neighbouring mountains covered with snow. It contains valleys of arable land, and is deemed capable of settlement."

Some account of the bay of San Francisco will form a useful conclusion to this account of the physical and descriptive geography of the gold district of California. "This remarkable bay, celebrated since its first discovery as one of the finest in the world, is separated from the sea by low mountain-ranges. Looking from the peaks of the Sierra Nevada, the coast-mountains present an apparently continuous line, with only a single gap resembling a mountain-pass. This is the entrance to the great bay, and is the only water-communi-

cation from the coast to the interior country. Approaching from the sea the coast presents a bold outline. On the south, the bordering mountains come down in a narrow ridge of broken hills terminating in a precipitous point, against which the sea breaks heavily. On the northern side the mountains present a bold promontory, rising in a few miles to the height of two or three thousand feet. Between these points is the strait—about one mile broad in the narrowest part, and five miles long from the sea to the bay. Passing through this gate the bay opens to the right and left, extending in each direction about 35 miles, having a total length of more than 70, and a coast-line of about 275 miles. It is divided by straits and projecting points into three separate bays, of which the northern two are called respectively the San Pablo and Suissoon bays. Within the bay the view presented is that of a mountainous country, the bay itself resembling a long lake lying between parallel ranges of mountains. Islands, which have the bold character of the shores —some being mere masses of rock, and others grass-covered,—rise to the height of from 300 to 800 feet, breaking the monotony of its surface, and adding to its picturesque appearance. Directly fronting the entrance, mountains, a few miles from the shore, rise about 2000 feet above

the water, crowned by a forest of lofty cypress, which is visible from the sea and makes a conspicuous land-mark for vessels entering the bay. Behind, the rugged peak of Mount Diavolo, nearly 4000 feet high (3770), overlooks the surrounding country of the bay and San Joaquin. The immediate shore of the bay derives, from its proximate and opposite relation to the sea, the name of *contra costa* (counter coast, or opposite coast). It presents a varied character of rugged and broken hills, rolling and undulating land, and rich alluvial shores, backed by fertile and wooded ranges, suitable for towns, villages and farms, with which it is beginning to be dotted. A low alluvial bottom-land, several miles in breadth, with occasional open woods of oak, borders the foot of the mountains around the southern arm of the bay, terminating on a breadth of twenty miles in the fertile valley of the St. Joseph, a narrow plain of rich soil lying between ranges from 2000 to 3000 feet high.

"The strait of Carquines, about one mile wide and eight or ten fathoms deep, connects the San Pablo and Suissoon bays. Around these bays, smaller valleys open into the bordering country, and some of the streams have a short launch navigation, which serves to convey produce to the bay.

"The Suissoon is connected with an expansion of the river, formed by the junction of the Sacramento and San Joaquin, which enter the Francisco bay in nearly the same latitude as the mouth of the Tagus at Lisbon. A delta of twenty-five miles in length, divided into islands by deep channels, connects the bay with the valley of the San Joaquin and Sacramento, into the mouths of which the tide flows, and which enter the bay together as one river.

"Such is the bay, and such the adjacent country and shores of the bay of San Francisco. It is not a mere indentation of the coast, but a little sea in itself, connected with the ocean by a gate opening out between seventy and eighty miles to the right and left, with a breadth of ten or fifteen miles—deep enough for the largest ships—with bold shores and a fertile adjacent country. The head of the bay is about forty miles from the sea, and at that point commences its connexion with the noble valleys of San Joaquin and Sacramento."

CHAPTER III.

GEOLOGY OF CALIFORNIA.

LITTLE is known as yet with accuracy as to the geological structure of the parent rocks, either in the upper part of the Sacramento river or in the enclosing ranges; and indeed up to a recent period even the physical geography of the whole country, north of the Gulf of California, between the old boundary of the United States and the coast-range, has remained in great obscurity. It is however quite clear that the volcanic character, and probably therefore the trachytes and other rocks of comparatively recent origin, so abundant in Mexico, are continued northwards, so that here as elsewhere along the American line of coast bordering the Pacific, recent elevation has been the result of recent and still-continued volcanic action. It has been already mentioned that the main range of the peninsula of Old California extends northwestward towards San Francisco, gradually declining in elevation, and forming what is called the coast-range, throwing off many lateral spurs. Within the peninsula this range is distinctly volcanic, and is described by Mr. Farnham as "a

thirsty mass of burning rocks, so dry that vegetation finds no resting-place among them, but lifting themselves nobly to the clouds, and looking venerable in their baldness." "They stand a vast assemblage of red and brown dearth, extending in a bold, jagged line, broader and higher onward and upward, till they fade away among the bright clouds and dewy skies of Lower California."

Notwithstanding this desolation, the very fact of there being a vast mass of volcanic erupted rocks redeems this land from hopeless and continued barrenness; and were it not exposed to the influence of frightful tornadoes, the vegetation, growing on such of these rocks as have had time to decompose, would still feed a large population with facility. The mountains of the range vary in height from one to five thousand feet above the sea, and the country suffers much for want of water, the porousness of the rocks allowing the rain that falls to penetrate at once beneath the surface and escape to the sea.

The volcanic range on the Pacific side is parallel to a similar and loftier series on the eastern or continental side of the peninsula of California, and the two ranges together, terminating northwards in an elevated plateau, gradually combine and culminate in the lofty mountain of San Bernardin. They afterwards again diverge, forming the two

chains already described, enclosing the valley of the Tule lakes. The eastern is described by Mr. Farnham as a wide and lofty range, partaking strongly of the volcanic character of the more southerly ridge. One of its peaks, Mount Jackson, towers above all the rest several thousand feet, and is constantly capped with snow: mountains of great height are piled around it, but they appear like molehills in comparison, though some of them are so high as to be covered with snow most part of the year.

From this point northwards, the true snowy range or Sierra Nevada carries on the chain of highlands as far as the Oregon territory, and there meets with another and transverse group of mountains extending from Cape Mendocino north-eastwards, and culminating at Mount Shasti. Near the sea the rocks are described as primitive, and are probably porphyries of varied character, like those occurring further south and also in the Rocky Mountains.

About seventy miles north-eastwards from the bay of San Francisco, a spur is given off from the chain of the Sierra Nevada which contains an active volcano, and exhibits all the characteristics of recent volcanic action.

The geology of the main chain of mountains to the south, of which all those of California form a

west branch, is also interesting, and bears directly on the subject we are now considering. Porphyries and limestones there form the flanks of the chief elevations and of the whole central ridge; these have been elevated often to considerable heights; and after them appear rocks more distinctly volcanic, presenting either true *coulées* of lava or trachytic rocks, which on the plateau occupy vast tracts by the side of the porphyries, and of which it is often difficult to determine whether they or the porphyries are overlying. It is highly important to remark that extensive lacustrine deposits repose on these, and consist of rounded flints covered by marls and hardened clays.

On the Pacific coast granite comes more into view, but does not rise to any considerable height, while further north than Mexico, as at Durango, trachytic rocks, occasionally metalliferous, are crossed at various points by lava-currents. As they advance further north in the same direction, the distinctly volcanic products are gradually less nearly in contact, while altered schists, diorites and metamorphic limestones appear, and are traversed by auriferous veins of quartz often containing also much silver. The principal direction of the metalliferous district, as drawn by M. Duport in the map appended to his recent work on the production of the precious metals in Mexico,

passes directly into the Sierra Nevada, and continues to bear metal as far as it has yet been fairly examined.

It appears, also, that the alluvia derived from these veins is throughout the range chiefly on the western side.

As the best and most useful information, in the absence of direct and authentic accounts of the matrix of the gold in these districts, we will now give an abstract of Humboldt's account of the auriferous rocks of the most nearly allied and adjacent countries in South America.

"The porphyroid rocks of equinoctial America form the prevailing geological type of that country, and no part of the world contains a greater mass of porphyries than the cordillera or chain of mountains which extends in America, almost in the direction of a meridian, 2500 leagues from one hemisphere to the other. These porphyries, in part rich in ores of gold and silver, are most frequently associated with trachytes, by which they are covered, and through which the volcanic agents still penetrate. This association of metalliferous rocks with rocks produced or changed by fire, would less astonish the geologists of Europe if it extended only to specular iron, titaniferous iron, and muriate of copper, and not, as it does, to gold and silver. This latter phænomenon is striking,

and is opposed to the opinions long entertained by celebrated men. It is, however, a fact very necessary to be well determined, that there is a proximity of position and sometimes an analogy in the composition of rocks without an identity of formation.

"The porphyries of South America may be considered in two ways; according to their geographical position, and according to the dates of their formation. These rocks occur together on a narrow land in the most western and most elevated part of the continent, on the shore of that immense basin of the Pacific Ocean which is bounded on the other or Asiatic side by the volcanos and trachytic rocks of the Kuriles, Japanese, Philippine and Molucca islands. At the east of the Andes throughout the whole eastern part of South America, on a space of ground amounting to more than 500,000 square miles, no transition porphyry, nor real basalt with olivine, nor trachyte, nor burning volcano, have been observed, either in the plains or the groups of insulated mountains. The phænomena of the trachyte formation appear to be confined to the ridge and the line of the Andes of Chili, Peru, New Granada, St. Martha, and Merida. I announce this circumstance in a particular manner, in order that travellers may be induced to confirm it by farther examination or

refute it. In the same region which extends from the eastern declivity of the Andes towards the coast of Guiana and Brazil, gold, platina, palladium, tin, and an immense quantity of specular and magnetic iron, have been found; but amidst many indications of sulphuret or muriate of silver, no mine has been discovered which can be compared in richness to those of Peru and Mexico. I did not see transition porphyries, nor the porphyries of red sandstone, in the chain on the coast of Venezuela in the Sierra de la Parima, nor in the plains between the Orinoko, the Rio Negro, and the Amazon river.

"With respect to the nature of the formations of porphyry which exist so abundantly in the western and mountainous land of South America and in that of Mexico, which is but a prolongation of the same land, I shall describe two very distinct groups in that place. The first (not metalliferous) reposes immediately on primitive rocks; the second, often metalliferous, rests on clay-slate or on talcose slate with transition limestone; both of these by their position and composition sometimes resemble trachytic porphyries, as the porphyries of the group resemble those of the red sandstone. In fact, the transition porphyries of the Andes of Peru and Mexico are often found covered by trachytes, while the porphyries of some parts of Ger-

many are covered by the secondary formation of red sandstone, which contains in its turn porphyries and amygdaloid. In equinoctial America, the limits between transition porphyries and real trachytes known to be volcanic rocks are not easy to fix. In ascending from the porphyries which contain the rich silver-mines of Pachuca, Real del Monte, and Morau (porphyries destitute of quartz, but often abounding in hornblende and common felspar), towards the white trachytes with pearlstone and obsidian of Oyamel and of Gerro de las Navajas (mountain des Couteaux, to the east of Mexico), and in passing, in the Andes of Popayan, transition porphyries covered on some points with fine-grained black limestone, to the pumice-trachytes that surround the volcano of Puracé, we find intermediary porphyritic rocks which we are tempted sometimes to regard as transition porphyries, sometimes as trachytes. To this may be added, that amidst these porphyries of Mexico, so rich in gold and silver, we observe beds (Villalpando, near Guanaxuato) destitute of hornblende, but containing slender crystals of glassy felspar. They cannot be distinguished from some of the phonolites of Bohemia. The transition porphyries of New Spain contain generally two species of felspar, the common and the vitreous. It appears that the latter is more abun-

dant in the upper beds, in proportion as we approach the trachyte porphyries*."

I have quoted thus much on the subject, thinking it may afford useful suggestions, should any of those who are now about to investigate California with a view to discover gold, be inclined at the same time to make observations on the circumstances under which the gold matrix appears in relation to the rocks in the vicinity.

It appears then from what has been said, that the district north of San Francisco, from which the gold has hitherto been obtained, is a broad tract enclosed on the east by a lofty and recently elevated tract, partly volcanic, partly trachytic, but exhibiting everywhere igneous rocks, perhaps not unlike much of that singular mass of quartz rock, porphyry and jasper which abounds in the Ural ridges, especially on the Siberian side, and in the gold-producing countries in South America. In the former districts it is true that the volcanic influence is not now traceable, but there are abundant proofs of igneous action on a very grand scale, and volcanos themselves are not wanting in Eastern Asia.

The valley of the Sacramento, described in Col. Fremont's report, takes its origin in several parts of the Sierra Nevada, and in the transverse range

* Humboldt's Geognostical Essay, Eng. Transl. p. 151 *et seq.*

proceeding from the coast at Cape Mendocino. Several of these affluents have received names, and many of them at their junction with the main streams present considerable quantities of alluvial gold mingled with their lands and detritus. They appear to be of the nature of mountain streams, often dry and sometimes becoming boiling torrents. The one called the Rio de los Americanes, entering low down the river, and near where it enters the bay of San Francisco, has hitherto proved the most productive.

About twenty-five miles up this stream from the fork is the spot called Lower Mines or 'Mormon diggings,' and both here and still further up where this stream itself forks, washings have been carried on with great success. On the south fork on both banks gold has been found in large quantities, and it is clearly derived from the mountains to the east, the country rising rapidly and becoming wild and barren in the upper part of the subsidiary valleys, which ultimately become mere gullies. It appears perfectly clear that almost all the district through which run the numerous small streamlets that ultimately form the Rio de los Americanes, runs over beds of alluvial matter containing large quantities of gold, and thus there appears to be an area of very many square miles, any part of which may fairly be tried for gold-washing with good prospect of success.

At this spot a large number of persons are employed, and the average produce of a party of four men in washing is said to be worth about £20 sterling per day. An official despatch forwarded to the American Secretary of State says, "I was two nights at a tent occupied by eight Americans, namely two sailors, one clerk, two carpenters, and three daily workmen. These men were in company, had two machines, each made from 100 feet of boards (worth there 150 dollars, but in Monterey 15 dollars, being one day's work), made similar to a child's cradle ten feet long without the ends. The two evenings I saw these eight men bring to their tents the labour of the day, I suppose they made each fifty dollars per day; their own calculation was two pounds of gold a day, four ounces to a man,—sixty-four dollars. I saw two brothers that worked together, and only worked by washing the dirt in a tin pan, weigh the gold they obtained in one day; the result was seven dollars to one, eighty-two dollars to the other."

About five-and-twenty miles north of the mouth of the Rio de los Americanes, the small stream called Rio de los Plumas (Feather river) enters the Sacramento. We are told in an official report by Capt. Mason, the military commander of California under the United States' government, that a company of men with about fifty Indians worked

in the valley of this stream seven weeks and two days, and obtained in that time 273 lbs. weight of gold (the value of which would be about £16,000). The gold was taken chiefly on the banks of the river from the surface to eighteen inches in depth. On this river there are several branches in which the people are digging for gold.

Other streams have also been searched, and it appears that most of those coming down from the same range have yielded large quantities of gold; but we forbear to give mere reports, however probable. The simple facts of the case, weeded of all hypothesis and of the possibilities that may result in districts yet untried, are quite sufficient to astonish the minds of sober Englishmen, and will hardly meet with the credit which they really appear to deserve.

We conclude the present chapter with a short extract from a newspaper published on the spot on the 14th of August last:—"The country from the Ajuba to the San Joaquin rivers, a distance of about 120 miles, and from the base towards the summit of the mountains as far as Snow Hill, about 70 miles, has been explored, and gold found on every part. There are now probably 3000 people, including Indians, engaged collecting gold. The amount collected by each man who works ranges from 10 dollars to 350 dollars per day.

The publisher of this paper, while on a tour alone to the mining district, collected, with the aid of a shovel, pick and tin pan, about twenty inches in diameter, from 44 dollars to 128 dollars a-day, averaging 100 dollars. The gross amount collected will probably exceed 600,000 dollars, of which amount our merchants have received about 250,000 dollars worth for goods, sold all within the short space of eight weeks. The largest piece of gold known to be found weighed four pounds."

CHAPTER IV.

THE GEOLOGICAL POSITION OF GOLD IN VARIOUS ROCKS.

Gold, which has hitherto been found either pure or alloyed only with other metals, usually occurs disseminated or distributed in minute quantities in the parent rock, which is generally either quartz or at least very quartzose. The metal is however by no means confined to this substance, being found also in clay-slate and limestone, as well as with granite and various other igneous and metamorphic rocks. It is usually associated with iron, often in the form of auriferous iron pyrites, sometimes with silver, tellurium and platinum, and occasionally with rarer metals such as palladium, iridium, osmium, rhodium, &c., which are chiefly interesting as mineralogical curiosities. Other minerals associated with gold are copper pyrites, blende, galena, and sulphur.

The gold of commerce is obtained chiefly from sands and gravels produced from disintegration of the parent rock on the spot, or transported by water from districts where much gold is disseminated. Such sands, &c. contain amongst them fragments

of gold consisting of lumps of various sizes. A quantity, small in proportion to the whole supply (not more than one-sixth), is also obtained from true mineral veins, in which gold is associated with veins of quartz in rocks usually schistose. The quartz in these cases is generally (but not always) cellular, rusty (from the presence of iron), and of loose texture; and the metal is usually disseminated also in the rock enclosing the vein, although perhaps not to any considerable extent. Few important and very profitable gold mines have been worked in veins, but the existence of large and little-worn lumps of gold *in situ* proves that this negative evidence must not be regarded as having any great value. At present, the mines of Gongo Soco in Brazil, and others in that country, are extensively worked in veins, and yield a somewhat considerable amount of gold; but the expenses are heavy, and the material obtained by mining not much more productive than the alluvial soils in less-worked auriferous districts*. I proceed now to explain some details of the position of the gold, first, in the principal alluvial districts in the Old

* That this is the case on a large scale, is evident from the price-list of shares in foreign mining companies working the precious metals. Not one of these has been able to manage matters so that the shares are now worth the amount paid on them originally. Many of them pay no return whatever to the original shareholders.

World, and afterwards in Brazil and elsewhere, where operations connected with gold-seeking are conducted on a large scale.

Of all alluvial districts that have been long known and are now worked, those of Russia are by far the most remarkable and the products most valuable. In this vast territory the gold alluvium is almost entirely confined to the eastern flanks of the Ural Mountains, and the affluents of the small streams fed immediately by the drainage of that mountain chain are chiefly the sites which the auriferous detritus occupies. It consists there of a gravel seldom less coarse than that round London and the east of England, and is for the most part a shingle composed of moderate-sized and small subangular fragments of the adjacent rocks, having been derived from rocks impregnated with gold or containing auriferous veins.

In the well-known and important mines of Berezovsk, near Ekaterinburg, granite dykes or bands in talcose and chloritic schists and clay-slates contain the gold particles. This granite itself contains the auriferous veins of quartz. It is easy to understand that a rock thus constituted must, if exposed to much denuding action, be separated into its component parts; and these again, when removed by water, will be separated or shifted, the heaviest portions being first deposited, and then

others in order. Thus, as the rate of progress of currents of water is greatly influenced by the form of land and the nature of the country over which it passes, there will always be some spots where a slight check will take place, and where, therefore, rocks or metals that have just been transported so far, and were nearly about to sink, will be collected and accumulated. More or less, however, there will be a deposit of all kinds of materials in different parts, especially where the water has passed over the land with variable force and in various directions. Rocks containing veins in which gold is but sparingly distributed and by no means repaying the cost of working, may, by this natural process of sifting on a large scale, at length become sufficiently rich as alluvia to yield a large return of profit by careful selection of a working place and good mechanical contrivances.

We will now quote from the great work on Russia, by Sir Roderick Murchison, a paragraph explaining the geological conditions of the gold deposits of the Ural.

"Gold-bearing alluvia have been found at various spots nearly all along the eastern flank of the Ural chain, both in the lateral or north and south, and in the transverse, or east and west valleys, formed amid the rocks which we have formerly described. These auriferous alluvia, especially rich

along the zone where greenstones, porphyries, and serpentines have traversed ancient limestones, have been followed by the Russian miners to the north of Petropavlosk, between which place and Berezovsk the excavations and works have been numerous. Around the Zavods of Nijny-Tagilsk and Blagodat, and even extending to the western talus of the watershed, these gold alluvia have been considerably worked, and in some instances the ore of platinum is formed in the very same masses. In reference to the works depending on Nijny-Tagilsk, it may be stated that the zone which ranges close along the western side of the crest of the chain is poor in gold, the particles of which are associated with chromate of iron and platinum, and are supposed to have been derived from the hornblende and metamorphic rocks which there rise up to form the axis. The richest band is that which runs from north to south, a little to the east of Laisk, whilst two other but poorer zones occur in the mineralized low ridges still further east, or at forty and sixty versts from Nijny-Tagilsk. In this parallel of latitude, therefore, the gold-bearing detritus is found at intervals, and in zones extending from north to south over a country near 100 versts in width, and is everywhere made up of fragments of the metamorphic and eruptive rocks of the region, and most frequently in por-

tions of quartz veins. Varying in thickness and importance according to the original depression or cavities in which they have been deposited, these materials lie at all levels, the little modern streams having had no sort of influence in accumulating them*."

Generally the gold obtained by washings, and coming under the denomination of alluvial gold, is everywhere present in comparatively small proportion in the quartzose sand covering very extensive areas. But this is not always the case. In Siberia there appears to be a distinct epoch to which the auriferous alluvium belongs, and over such beds are others forming a capping often of clay and shingle containing no gold. It may easily happen in any other country as in Siberia, that there are alluvia of different ages obtained from rocks at a distance, or from the decomposition and disintegration of those *in situ*, some of them containing certain minerals, while others are totally deprived of them. Some attention therefore is required, not only in the selection of a spot which may be supposed to contain the proper mineral, but in finding out whether the gold is present at all, or in greatest abundance in any particular bed.

The origin of auriferous gravel is a question of vital importance in all gold-producing countries.

* Murchison's Russia, vol. i. p. 479.

Already we hear of the prospects in California being so important, because, "after the earth shall all be washed, we have still the *mines* untouched of which the gold thus obtained is manifestly the waste—the overplus—the superabundance scattered about." And however this may be thought unreasonable by those who have made themselves acquainted with the history of other similar mineral districts, many will no doubt dwell upon it as something little short of absolute certainty. All the evidence therefore that bears on this part of the question, obtained from other countries, is worthy of attention, and the possibility, at least, of the metal found consisting of portions which have been disseminated through rocks subsequently exposed to denudation, should never be lost sight of.

In the Ural district, the position of the detritus, containing even rich deposits of gold, is sometimes very peculiar, and distinctly proves that mere alluvial action at the present relative level of land and sea could not have been concerned in producing the auriferous gravel. The case at Miask is remarkable in this respect; and as this spot and its vicinity have yielded some of the largest detached masses of gold ever obtained, it deserves some attention. Here and elsewhere the edges of rocks inclined at a high angle to the horizon, and even the summits

of hills of considerable altitude, are covered with fragments of quartz veins; and in the hollows are lumps of gold, apparently portions of rich nests of ore. But here the works have been entirely confined to the gravel, although there are certainly indications which would warrant the seeking for veins.

The general result of the investigations that have been made in the Ural districts and the gold-mines of Western Siberia, would induce the careful observer to doubt the expediency of depending upon any supplies from veins. The quantity of gold now present in the sands and gravel is large, perhaps owing to the length of time during which the deposit was in progress, the amount of denudation, and local circumstances favouring the accumulation; but there is no probability, either from actual investigation or decided surface indications, of any one part being so much richer than another as to justify the spending a large amount in following a stream to its source. Even in the richest of these spots in the Miask district, when the auriferous detritus, which is ten or twelve feet thick, is removed, the fundamental rock is found hollowed into cavities, which have been produced by the eroding action of water very long continued. Whether this took place when the gold was deposited, or at some more recent period, there can

be little encouragement or support to the idea that the immediately underlying rocks necessarily contain valuable veins.

The gold obtained from Brazil is partly from washings and partly from true veins. The former occurs generally in loose, roundish or flat grains, and often with iron-mica in association with quartz-sand. It is however derived from the granitic and gneissic rocks of the district, and particularly from those veins of quartz which run through them in bands, more or less inclined to the horizon. This substance appears to have been formed at some distant period by the process of segregation, and the various small veins all tend to some larger one, and finally terminate in a general mass, which now fills what appears to have been a passage or chamber in the body of the mountain, and which, according to the language of Brazilian miners, may be called the *Caldeirao* or centre. These veins are described by an intelligent traveller, Mr. Luccock, as the only natural beds of gold and the matrix in which it is formed; for though not always enriched with metal, such bellies or pockets answer, in many respects, to somewhat similar veins, in a different kind of mountains, where lead is discovered.

The district of St. Joan del Rey seems to be composed of a soft kind of gneiss, which is re-

markably full of narrow veins of quartz, running through it in plains nearly perpendicular to the horizon. In these alone, and in no other part of the mountain, the gold is found in its matrix traversing the spar in small threads, or filling up every interstice which it finds between the crystals so completely, as to appear like metal fused and poured into a mould, of which it takes the exact form.

The common *Cascalho** of the country, an indurated soil in which gold is contained, seems to consist of the fragments of those veins which have been by some means broken up, rolled about by the action of water in agitation, and buried by it among the clays which have composed its bed. These fragments and half-rounded masses, it is evident, must have contained the metal completely formed before the period of their disruption, however long it may have been since that event took place; nevertheless, none of these cases prove that

* There is a difference between the *cascalho* or auriferous gravel in the mountains and that in the rivers: the imbedded stones in the mountain *cascalho* are rough and angular, but in that of rivers they are rounded. Hence it has been argued by some that the gold in the rivers has not been brought down from the hills, as is commonly supposed; and this seems the more probable, because the gold, though found in lumps, has not itself been rounded. It is not unlikely that this condition is indicative of the gold alluvium not being the most recent of the gravel deposits of the country.

the process has not been continually going on, and that there is no recently-formed gold; indeed, old miners say, that it grows,—that beds formerly wrought contain now a larger quantity than it is possible to suppose their ancestors would have left in them; however, the evidence of this is by no means satisfactory, and if it is in any sense true, it is only that the work of decomposition of the matrix is still going on, and a fresh supply of gold being therefore laid bare from time to time.

On the upper surface of another district, the Serro of Lenheiro, and indeed on most of the clays, there is a large quantity of felspar and quartz, in nodules; yet it is said that no gold was ever found among them; indeed, these nodules seem to have been formed in a very different period and by a very different process from that which has produced the auriferous veins; none but these veins appearing to be the natural and native beds of the metal. Yet these veins are so narrow, so hard, so little affected by the action of water, and so completely secured from attrition of every kind, except on their outer edges, that it is impossible to suppose the quantity which has been obtained from the mine of St. Joan del Rey should be derived only from the veins which ter-

minate in it. A portion of precious dust must have existed on the soil of the mountain, and have been brought down from the surface by the waters which have flowed over it. It was placed there perhaps by the same means as the mica was when the solid rocks were decomposed.

The *Caldeiraos*, or those parts in the body of the mountains where the metal exists in large masses, and almost pure, are of two kinds; those in the solid granite rocks seem to be the chambers whither the menstruum which held in solution the precious ore has tended,—where it has rested and deposited the metal with which it was saturated: those which are found in the softer mountains appear to be of later formation, and were probably the lower parts in the bed of a current, a lake, or the ocean, whither the heavy metal, previously existing in the form of dust among the mud of its bottom, has tended and been finally collected. Upon the whole, it seems that all gold found in the state of dust, whether it be in the beds of rivers, among soils or sands, or even schist, has been subject to the action of water, and removed from the body or matrix in which it was first formed. Hence probably it is that we find it more abundantly in valleys than on the summits and sides of hills, and in masses, either at considerable depths under the surface of

mountains, or near that of low levels, and never in such a form in any other situation*.

In various parts of Brazil the gold is found, as for example in some of the richest mines of Villa Rica, spread over the country in the schist or slaty clay, which there appears at the surface. This schist rests on a nucleus of granite, gneiss or sandstone, sometimes laminated but elsewhere solid, the gold being scattered in small particles throughout the clayey rock. At present, there is in this district of Villa Rica a single deep outlet for the waters of several streams eaten away by their force through the softer beds which enclose a high plateau.

Before this outlet, called the Rio do Carmo, became so deep as it is, a small lake must have existed among the hills through which all the waters of the upper country passed, bringing with them and depositing in the bottom a variety of heavy matter. Thus the ground seems to have been gradually raised, while the outlet was deepened, until the water was entirely drained off, and left the bottom dry in the form of a level plain, composed of all sorts of wreck, which, from the auriferous nature of the country, contained a considerable proportion of gold, both in the form of

* Luccock's notes on Rio de Janeiro and the southern parts of Brazil from 1808 to 1818.

dust mingled with the pounded schist and imbedded in quartz, as *cascalho*. The extent of this plain is from thirty to forty acres, and it is connected by narrow passes with others of a like size. The mountains surrounding this supposed ancient lake rise from 700 to 1000 feet above its level, and on the declivity of the most northern of them the city is built. In the sides of all of them much gold is undoubtedly still detained, notwithstanding the quantity which has been washed down or gathered from them. The comparatively small plain above-mentioned may however be considered as the swan which, through a succession of years, has laid golden eggs for the crown of Portugal: its surface is only just even with the stream flowing through it, and after much rain it is always flooded. The whole is considered public property; and any person may cut trenches from the stream, and conduct them in any direction he pleases, provided the ground be not previously occupied by another adventurer. After the spot has been recently flooded, the inhabitants of Villa Rica are said to turn out *en masse*, to pursue with ardour the search for gold, and do not desist until the whole of the impregnated surface is completely ransacked; but in the dry season scarcely half a dozen miners are seen at work.

When the mountains were first discovered to be auriferous, it is said that the searchers for gold did nothing more than pull up the tufts of grass from the side of the hill and shook the precious dust from the roots. This will probably be treated as a romantic tale by all who have not examined the spot, but the fact may be easily explained: the steep slope of the mountain is covered with a coarse kind of grass or rushes, in small clumps or bunches; hence when rain falls heavily, little streamlets or rills pass round and between the roots, and whatever of a ponderous nature they hurry downwards must be detained wherever their rapidity is checked. This happens at every tuft of rushes which stands directly in the little water-course, and hence these roots probably become rich in metal, and, at the time of the discovery, had been undisturbed for ages; those who pulled the grass consequently would find the gold, and those who plucked a second crop would as surely be disappointed. As these streamlets likewise descended the hill, collecting a greater quantity of water, they acquired more force, and formed for themselves, by tearing away the soil, a course having an irregular bottom, with hollows in the softer parts, in the form of basins, in which the descending metal must be retained. Probably in this way some of those smaller caldeiraos were

formed, which often suddenly enrich the adventurer, and of which so much is said by those who envy their good fortune.

The gold hitherto found in California is, like that of the Ural and Brazil, obtained from alluvial sand and gravel. It is described by the various persons who have seen it, as being mixed with, and forming part of, quartz rock and pebbles:—as occurring in the mud and gravel which form the actual present beds of rivers and streams:—and also as occurring in the former and now dry beds of such streams. As will be seen in the accounts we shall have to give of the washings in the next chapter, the gravel consists of coarse and small stones mixed with mud and fine sand, but willow baskets have been sufficient to sift this gravel coarsely. The crevices of the rocks are mentioned as containing a good supply, which can be discovered and picked out with knives.

The depth of the deposit has not yet been determined, as all present operations are merely at the surface; but it seems quite clear that the alluvial soil over several small valleys, emptying themselves into the principal stream (the Sacramento), is uniformly auriferous, being throughout loaded with gold in various degrees of mechanical division; and judging from specimens which have come to this country, and which have been seen

by the author, they are probably derived from narrow veins in hard rock. They consist chiefly of thin, but not extremely thin laminæ of definite size, but are unquestionably mixed up with a very much larger proportion of particles extremely minute, and requiring careful management to preserve.

There is no evidence at present concerning even the probable position of the source of the metal, except that the direction of the streams would point to the lofty mountains of the Sierra Nevada, as the source of the gold as well as of the waters that convey it.

The cases in which true auriferous veins occur in crystalline rocks are by no means rare, but the quantity of gold in such cases is so small in proportion to the rock in which it is disseminated as scarcely to repay the cost of working. Such veins are found in most districts where quartz rock abounds.

There are some remarkable examples in which small veins of auriferous ore and disseminated gold are worked to advantage, chiefly in metamorphic rocks, and this is strikingly the case in the celebrated Brazilian mine of Gongo Soco, already more than once referred to. The produce of this mine for twelve years has amounted to as much as 30,000 pounds weight (worth consider-

ably more than a million and a half sterling). In this locality the gold is disseminated in thin foliated particles, in scales, and in threads through stratified rocks, of which there are four distinct kinds, two of them metamorphic and offering many metallic combinations.

The chief auriferous rock is that called *iacotinga*, a quartzose rock, compact, of a reddish colour and laminated texture. The separation of the laminæ is marked by black flakes of iron glance, such as are often found in certain volcanic rocks. The gold occurs in small dendritic and foliated particles, especially near the iron glance.

Above the iacotinga is a sandstone composed of crystalline and translucent grains of quartz, containing, in the planes of stratification, both iron glance and carbonate of manganese. Native gold accompanies these two minerals, and is found both in geodes of crystalline appearance and in dendritic portions.

Gold exists also between the laminæ of a talcose schist, and a bluish satiny clay-slate, in contact with the preceding rocks. The native gold occurs there in flakes or foliated masses, whose thickness is sometimes more than half a line ($\frac{1}{24}$th of an inch), but which are generally very thin, although they have been found as much as ten inches long. The chief difference between the position of the gold

in the quartzose rocks and schists is, that these last contain neither iron glance nor manganese ore.

The workings take place in all the rocks above described, but the most productive and important is the iacotinga; and this is also the rock most easily mined*.

The workings for gold in Transylvania and Hungary are sometimes described as examples of gold-mining, but they are not so in the proper sense of the term, as although, in point of value, the gold is the important product, the ores are of auriferous silver, or of a combination of silver, lead, gold and tellurium.

The gold-bearing rocks hitherto worked in the United States are, to a great extent, micaceous or talcose schist with veins or beds of quartz; the gold not being confined to the veins, but extending into the rock on either side. The veins now worked in Orange county in Virginia, are described as running N.N.E. and S.S.W., and dipping to N.E., the ores consisting of iron pyrites, various oxides and hydrous oxides of iron, and sulphuret of copper, all rich in native gold.

* Dufresnoy's 'Minéralogie,' t. iii. p. 206.

CHAPTER V.

THE MINERALOGICAL AND OTHER CHARACTERISTICS OF GOLD, AND THE MODES OF DISTINGUISHING IT WHEN FOUND.

In proceeding now to describe in some detail the natural history characters of gold, and the modes of determining its presence and value (for even gold has not, under all forms, the same value), we may appear to repeat, to a small extent, what has been already said; but it is convenient to do so in order that this part of the subject may be distinctly presented to the reader.

Gold *invariably* exhibits something of the peculiar yellow colour which it is known to possess in a pure state; but this colour is modified by various metals with which it may be mixed. Thus it may be described as having various shades of gold-yellow; occasionally approaching silver-white, occasionally resembling brass-yellow of every degree of intensity, and even verging on steel-gray in some specimens from South America.

The lustre of gold is highly metallic and shining, and owing to the small amount of oxidation at its surface, it preserves its shining lustre even

after long exposure in contact with other substances. Thus the shining particles are often seen in sand when the quantity is barely sufficient to repay the cost of working, notwithstanding the value of the metal. Even however if the surface is dull the true colour and appearance are easily restored by rubbing, and when polished it takes a very vivid lustre, which is preserved for a long time in the atmosphere.

Although in the division which has been introduced into gold-yellow, brass-yellow, and greyish-yellow, native gold seems with some slight modifications to agree with the geological relations of its varieties; yet this mode of arrangement deserves little serious notice. The gold-yellow varieties comprise the specimens of the highest gold-yellow colours, though there are some among them which have rather a pale colour; they include most of the crystals and of the imitative shapes, in fact the greater part of the species itself. The brass-yellow native gold is confined to some of the regular and imitative shapes of a pale colour (which is generally called brass-yellow), and, as it is said, of a less specific gravity than the preceding one; but this does not seem to have ever been ascertained by direct experiment. The greyish-yellow native gold occurs only in those small flat grains which are mixed with the native platina, and possess a

yellow colour a little inclining to gray; they are said to have the greatest specific gravity of them all. The real foundation of this distribution seems to be the opinion, that the first are the purest, the second mixed with a little silver, and the third with platina. It is not known whether the latter admixture really takes place, but it is certain that several varieties of gold-yellow native gold contain an admixture of silver*.

In colour and lustre, inexperienced persons might mistake various substances for gold; these are chiefly iron and copper pyrites, but from them it may be readily distinguished, being softer than steel and very malleable, whereas iron pyrites is harder than steel, and copper pyrites is not malleable; for although the latter mineral yields easily to the point of a knife, it crumbles when we attempt to cut or hammer it, whereas gold may be separated in thin slices, or beaten out into thin plates by the hammer. There can thus be no possible difficulty in distinguishing these various minerals in a native state, even with nothing but an ordinary steel knife. From any other minerals, as mica, whose presence has also misled some persons, gold is easily known by very simple experiments with a pair of scales, or even by careful washing with water, for gold being much heavier

* Mohs' Mineralogy, by Haidinger, vol. ii. p. 438.

than any other substance found with it (except platina and one or two extremely rare metals), will always fall first to the bottom, if shaken in water with mud, while mica will generally be the last material to fall. This is the case however fine or few the particles of either mineral may be.

Gold therefore can be distinguished by its relative weight or specific gravity, and by its relative hardness, from other bodies which resemble it. It is described generally as soft, completely malleable and flexible, but more accurately as softer than iron, copper or silver, but harder than tin and lead. It is useful to know facts of this kind, as a simple experiment that can be made with instruments at hand, is often more valuable than a much more accurate examination requiring materials not immediately available. Thus if it is found that a specimen (perhaps a small scale or spangle) is readily scratched by silver, copper or iron, and scratches tin and lead, it may, if of the right colour and sinking rapidly in water, be fairly assumed to be gold.

The weight of gold, as of all substances, it is convenient to estimate relatively, and in comparison with the weight of an equal volume of water. The relative weight, or *specific gravity* as it is called, of gold is remarkably high, the lightest varieties being twelve times heavier than water, and pure

gold nineteen times. This is expressed by saying that the specific gravity of native gold is 12–19, and the number determined by comparing the weight of the mineral in water and air.

As the value of gold depends almost entirely on its specific gravity, and this test, therefore, is of the greatest practical importance, it will not be out of place if we here explain some very simple apparatus for the determination of this point.

If the specimen then is large enough to be suspended conveniently by a thread, weigh it first in air by a fine balance, expressing the result in grains, and taking care previously to remove dust or loosely adhering particles. Then suspend it by a horsehair from the scale-pan (it is convenient to have a hook attached to it for this purpose), and thus suspended, immerse it and re-weigh it in water, taking care that it is covered on all sides by at least half an inch of water, and carefully brushing off with a feather any bubbles of air that adhere to the surface. The results may then be noted as follows :—

Weight of substance in the air in grains	
Deduct weight of ditto in water	
Difference.....	

This result gives the weight of a bulk of water equal to that of the specimen, and by dividing the

weight of the specimen in air by this number, the specific gravity is obtained.

$$\text{Specific gravity} = \frac{\text{weight of substance in air}}{\text{weight of equal bulk of water.}}$$

If, however, the substance is in the form of fine sand or very small lumps, it is better, after weighing it carefully, to take a small dry phial furnished with a stopper; counterpoise this phial accurately in the weight-scale by shot or strips of lead, then fill it completely with pure water, taking care that no bubbles of air are left in, and weigh the quantity of water it contains: afterwards empty the bottle and dry it inside.

Next fill the bottle about two-thirds full of the powder to be examined, weigh this and record the weight. Then fill the bottle once more with water, taking care, as before, that all bubbles are expelled and none of the powder washed out. Once more weigh it.

We have then to make the following calculation:

Weight of powder and water in grains	=
Deduct weight of powder alone	=
Difference (weight of water left in bottle)	=
Weight of bottle full of water in grains	=
Weight of water left in bottle	=
Difference (weight of water displaced by, and equal in bulk to, powder)	=

$$\text{The specific gravity} = \frac{\text{weight of powder in air}}{\text{weight of water displaced.}}$$

It may be useful to know the specific gravity of various substances at all resembling gold either in weight or appearance, and we therefore append the following short table. The specific gravity of water is assumed to be unity:—

Osmium	$21\frac{1}{5}$	
Platinum	$19\frac{1}{2}$ — 22	not hammered*.
Iridium	$18\frac{7}{10}$	
Gold	$15\frac{3}{4}$ — $19\frac{1}{4}$	ditto
Mercury	$13\frac{1}{2}$	
Palladium	$11\frac{7}{10}$	
Lead	$11\frac{1}{4}$	
Rhodium	$10\frac{3}{5}$	
Silver	10	
Copper	$7\frac{3}{4}$ — 8	
Brass	$8\frac{1}{2}$	
Lead ore (galena)	$7\frac{1}{2}$	
Copper pyrites	5	
Iron pyrites	4	
Diamond	$3\frac{1}{2}$	
Sand	$2\frac{3}{5}$ — 3	

By the help of this table the value of auriferous sand may also be in some degree estimated, since, as will be seen, the specific gravity of most of the sands is under 3, while that of the most im-

* Metals, when hammered, become much more compact and have therefore a higher specific gravity.

pure gold is 12; so that if the specific gravity of the sands themselves, when experimented on, is much greater than that of ordinary sand, it is likely that the excess will be for the most part gold in a district otherwise known to be auriferous: the greater the specific gravity, too, the greater probability there is of this being the cause. It may also be worth while to mention here, that the specific gravity of those pepitas or lumps of gold which present a fine yellow colour varies generally from $14\frac{7}{10}$ to $14\frac{8}{10}$; but when much paler they may range as low as $12\frac{1}{2}$, which is that of a mineral called *electrum*, which will be described presently, and which is a mixture of silver and gold*.

When a piece of gold is broken (which is not done without difficulty—greater in proportion to its purity), the fractured edges are very uneven and torn, exhibiting a peculiar fibrous appearance, described by mineralogists as "fine hackly." This fracture indicates that the mineral is *torn asunder* and not really broken, and is a proof of considerable toughness.

The form in which gold is found is various. It is sometimes crystalline, in eight or twelve-sided regular figures, passing into cubes, but the crystals

* A *very rough* estimate of the value of specimens of native gold may be obtained by multiplying the specific gravity by 4; the result gives the value in shillings nearly.

are generally small and rare. In case of such crystals being found, it is well worth knowing that they possess a value as mineral specimens far beyond that of the gold which they contain.

More frequently the metal is found in lumps or grains, called by the Spaniards *pepitas*, varying in size from that of a pin's head to masses weighing, as has been already mentioned, nearly 100 lbs. troy. The term *pepita* is only applied to grains of some magnitude, and the most common limits of size are from that of a small pin's head to that of a nut or gooseberry.

When much smaller and still rounded, they are called *gold dust*, and when flattened, *scales* or *spangles*. In nature, and when seen in veins of quartz, gold often occurs *foliated*, or in leafy expansions of extreme thinness, or in branchy (*dendritic*) forms, probably made up of minute crystals. It is in the form of very minute grains that the metal is generally disseminated through rocks and auriferous ores of various metals, and these are reduced according to circumstances in methods that will be alluded to in a future chapter. In pepitas and small grains it is carried down by streams and deposited in their beds, the pepitas being usually most abundant where there is reason to suppose considerable disintegration of the surface and where the action of denuding causes to a great extent is evident. The coast of Africa

and the rivers of Europe are examples of the former case, while the Siberian deposits and those of California would appear to belong to the latter.

The following are examples of the constituent parts of various specimens of gold obtained from different gold districts, and will form a useful guide for comparison.

Table showing the Composition of Native Gold.*

Locality.	Gold.	Silver.	Copper.	Iron.
Auriferous sand of Schabrowski near Katherinenburg, Siberia (G. Rose)	98·76	0·16	0·35	0·05
Boruschka, near Nijny-Tagilsk, Siberia (Rose)	94·41	5·23	0·39	0·04
Brazil (Darcet)	94·00	5·85		
Beresovsk, Siberia (Rose)	93·78	5·94	0·08	
Sand near Miask, Siberia (Rose)	92·47	7·27	0·06	0·08
Bogota (Boussingault)	92·00	8·00		
Washings near Miask, Siberia (Rose)	89·35	10·65		
Gold of Senegal (Darcet)	86·97	10·53		
Auriferous sand, Nijny-Tagilsk, Siberia (Rose)	83·85	16·15		
Trinidad gold (Boussingault)	82·40	17·60		
Transylvanian gold (Ditto)	64·52	35·48		
Mine of Sinarowski in the Altai (Rose)	60·08	38·38	0·33	

The gold from California, according to the assay of Mr. Warwick of New York, yields 89·58 per cent. pure gold, and is therefore about equal to that obtained from the washings of Miask (the richest district in Western Siberia, and that producing the largest pepitas), and superior, as the assayer remarks, to the gold dust from Senegal.

There is a remarkable mixture of native gold with silver occasionally found in Siberia, and known under the name of *Electrum*. Its colour

* Abridged from Dufresnoy's 'Minéralogie,' before quoted.

is pale brass-yellow, passing into silver-white. It occurs in small plates and imperfect cubes, and possesses many of the characters of pure gold, but it consists only of 64 per cent. of that metal and 36 per cent. silver. It is at once known by its low specific gravity, which does not exceed 12.

Other mixtures of gold are (1) a *rhodium-gold* found in Mexico, and containing 34 to 43 per cent. of rhodium, having a specific gravity of $15\frac{1}{2}$—16·8, and a clear, dirty yellow colour; and (2) a *palladium-gold* (containing 9·85 per cent. palladium, and 4·17 per cent. silver) found in Brazil and elsewhere in South America, in small crystalline grains of pale yellow colour. The auriferous ores of tellurium, including silver, have hitherto only been found in Transylvania. Their colour is steel-gray, and they tarnish on exposure. The variety called graphic-gold, or graphic tellurium, consists of about 60 per cent. of tellurium, 30 per cent. gold, and 10 per cent. silver, and is worked chiefly as an ore of gold. Another variety, 'yellow gold glance,' yields somewhat less tellurium, gold and silver, and as much as 20 per cent. of lead.

Having now explained at some length the more manifest characteristics of gold, namely, its colour, hardness and specific gravity, it is necessary, before explaining the mode of separating it from associated minerals, that we should here give some

account of the behaviour of this metal under the blowpipe and when exposed to simple chemical tests. The assay of gold and its accurate analysis, we postpone for the present.

The method of blowpipe analysis, although exceedingly useful, is not absolutely necessary in the case of gold, because of the many readier ways of determining the metal, but it seems advisable to state the appearances presented. All the varieties are readily fusible into a globule, which, when the gold is pure, is unaltered by the continuance of the heat. In this respect it differs entirely from iron and copper pyrites, which, on being exposed to the flame, give off sulphur fumes and undergo considerable change. In the case of gold containing other metals, these, with the exception of silver, may generally be got rid of by continuing the heat in the exterior flame with the addition of a little nitre. Before the oxy-hydrogen blowpipe, the metal is volatilized in the form of a purple oxide.

Gold is not acted on by any of the acids alone. When exposed to the mixture of nitric with hydrochloric acid (in the proportion of one part nitric to four of hydrochloric) called *aqua regia*, it dissolves without residue, the solution giving a purple precipitate with protochloride of tin, and a brown precipitate with protosulphate of iron. Electrum,

the mixture of silver with gold above alluded to, is only partially soluble in aqua regia, giving a residue of chloride of silver. The solution is acted on by protosulphate of iron, as already explained.

The following simple mode of detecting attempts at imposition in gold dust is worthy of being recorded in this place.

Place a little gold dust in a glass tube or earthenware saucer and pour nitric acid upon it; then hold the glass or saucer over a flame, or upon a few embers, until red flames (nitric vapours) arise; if it be pure gold, the liquid will not become discoloured; but if pyrites or brass-filings should have been mixed with it, the acid will become turbid, green and black, discharging bubbles of gas. After the ebullition has ceased, the residue should be washed with water, and acid again poured upon it, when the same effect may be observed, but in a less degree; and if the experiment be repeated till all effervescence ceases, it will finally leave the gold-dust pure.

CHAPTER VI.

THE WASHING AND OTHER MECHANICAL TREATMENT OF ALLUVIAL ORES OF GOLD.

THE examination of rocks suspected to contain gold is a very simple matter, although the most convenient mode of actually obtaining the gold from the associated sand, mud or gravel necessarily involves mechanical contrivances, and requires more careful consideration. When a rock is supposed to be auriferous, or when the sands or other alluvial matter of a district are to be examined for gold, the rock should first be pounded fine and sifted:—a certain quantity of the sand thus obtained must be washed in a shallow iron pan, and as the gold sinks, the material above be allowed to pass off into some receptacle. The largest part of the gold is thus left in the angle of the pan; by a repetition of the process a further portion is obtained; and when the bulk of sand is reduced to a manageable quantity, the gold, if in too small a proportion to be readily removed (or the residuum in the latter case, after the richer particles have been carried away), is amalgamated with clean mercury; the amalgam is next strained to separate

any excess of mercury, and finally is heated and the mercury expelled, leaving the gold. In this way, by successive trials with the rock, the proportion of gold is quite accurately ascertained. Where the rock or gravel is rich, the amalgamation is unnecessary in a first trial, sufficient being obtained at once to give a large profit without any further process than simple washing.

The operation of hand-washing is called in Virginia *panning*; with a small iron pan they wash the earth in a tub or in some brook, and thus extract much gold. The gravel or soil is said to *pan well* or *pan poorly*, according to the result.

Masses of quartz with no external indication of gold, examined in the above way at a Virginia mine, afforded an average of more than eight dollars (35*s*.) to the bushel of gold-rock, which is equivalent to about five ounces of gold to a ton of rock.

The methods practically adopted to separate gold from alluvial soils containing any sensible proportion of this valuable metal, vary according to local circumstances and the tools that may be at hand. Washing on inclined tables is sometimes followed with advantage, as in Hungary, where a long plank is employed with a number of transverse grooves cut in its surface. This plank is held in an inclined position, and the sand to be

washed put in the first groove; they then throw water on it, when the gold mixed with some of the sand collects usually towards the lowest furrow. This mixture is removed into a flat wooden basin, and by a peculiar movement of the hand the gold is separated entirely from the sand. The stony ores are first pounded in a stamping-mill.

With the poorer ores, such as the auriferous sulphurets, whether of copper, iron or lead, it is usual to adopt the process of amalgamation, either after roasting or without submitting them to that process. This method however, belonging strictly to metallurgy, will not be described in this place, since at present the mechanical processes of separating the metal form the subject more immediately under consideration. I proceed therefore at once to describe the methods thus adopted; and as the Brazilian gold district is better known than any other, and the processes there adopted include most of the mechanical contrivances that have been from time to time introduced, our examples will be chiefly drawn from that country.

At the commencement of the mining* system

* The word 'mine,' in the signification attached to it by the inhabitants of Brazil, conveys a different meaning to that which it imports in Europe. Whilst in the latter it designates a subterraneous excavation, in the former it is simply applicable to the bed of a river, the bottom of a ravine, or some peculiar

in the Brazils, the common method of proceeding was to open a square pit, which the workmen called *cata*, till they came to the *cascalho**; this they broke up with pickaxes, and placing it in a wooden vessel, broad at the top and narrow at the bottom, exposed it to the action of running water, shaking it from side to side till the earth was washed away and the metallic particles had all subsided. Lumps of gold were often found from $2\frac{1}{2}$ to 12 ounces in weight, a few which weighed 25 to 38 ounces, and one it is asserted weighed 13 pounds; but these were insulated pieces, and the ground where they were discovered was not rich. All the first workings were in the beds of rivers, or in the table-land or flat alluvial banks over which the streams had at one time flowed.

In 1724 the method of mining had undergone a considerable alteration, introduced by some natives of the northern country: instead of opening the ground by hand, and carrying the cascalho thence to the water, the miners conducted water to the mining-ground, and, washing away the mould, broke up the cascalho in pits under a fall of the water, or exposed it to the same action in

place, of greater or less extent, where the soil is composed of alluvial matter containing metal.

* See *ante*, p. 60.

wooden troughs; and thus a great expense of human labour was spared.

At the commencement of the present century, there was a general complaint in Minas Geraës that the ground was exhausted of its gold; yet it was the opinion of many scientific men, that hitherto only the surface of the earth had been scratched, and that the veins were for the most part untouched. The mining was either in the beds of the streams or in the mountains; in process of time the rivers had changed their beds, and the miners discovered that the original beds were above the present level of the water and the banks of the streams, which formed as it were a second step, while the actual beds are the third and lowest. All these are mining-grounds: the first is easily worked, because little or no waters remain there; the surface had only to be removed, and then the cascalho was found. In the second terrace, wheels were often required to draw off the water, while the present bed of the stream could only be worked by making a new cut and diverting the stream; and even when this was done, the wheel was still necessary. The wheel was a clumsy machine, which it was frequently necessary to remove, an operation which occupied fifty slaves or more for a whole day; but it was the only means in use for saving human labour, for not even a cart or hand-barrow was to

be seen; the rubbish and the cascalho were all carried in troughs upon the heads of slaves, who in many instances had to climb up steep ascents where inclined planes might have been formed with very little trouble, and employed with great advantage.

River-mining however was the easiest and most readily performed, and it was therefore the commonest. But the greater part of those streams which were known to be auriferous at length were wrought. The mountains were more tempting, but required much greater labour; a few *braças*, if the veins were good, enriched the adventurers for ever, and in the early days of the mines, the high grounds attracted men who were more enterprising and persevering than their descendants. The mode of working in such ground is not by excavation, but by an open cutting, laying the vein bare by clearing away the surface. This labour is immense if water cannot be brought to act upon the spot; and when even there is water, it is not always easy to direct it, nor will the nature of the cut allow always of its use. When the miners found no cascalho in the mountains, they suspected that the stones might contain gold, and they were not deceived in the supposition. This is the most difficult mode of extraction, since the stones were broken by manual labour with iron

mallets; in a few instances, however, the machine was worked, but it was by slaves instead of cattle.

The modes of mining having been so imperfect, it has not unreasonably been concluded that when more scientific means are adopted, Brazil will still yield a considerable quantity of gold.

In the vicinity of St. John del Rey are several gold-washings that were formerly very rich. The principal mine is on the west side of the hill and close to the town, where the speculators have commenced their operations by digging into the bottom of the hill and excavating an area, three sides of which are formed by the rock, and the fourth is open towards the west. The texture of this rock is a soft red stone, or rather indurated clay mingled with mica, like the common soil of the country. In one part of the cleared area a hollow has been made, towards which there are channels from every part of the mine; so that all the water which can be conveyed thither goes into the well, and having no other outlet flows over its sides into a rivulet at the foot of the hill, passing towards the north. In working the mine the earth is thrown into the channels, and conducted through them by rakes and other means until it falls into the well, where, in consequence of new agitations, the metal sinks to the bottom and is separated from the refuse-matter. This is really

nothing more than a quarry, though called a mine, and in many points resembles the quarries whence stone is procured at Liverpool: it appears about half as large as the Parys Mountain mine was at the beginning of the present century, and fully as deep. The miners are encouraged to make such excavations, not so much for the sake of the metal disseminated through the rock, which they expect to meet with in its more common form and quantity, as with the hope of finding a *caldeirao* or mass of gold, one of which repays a man for the labour and expectation of several years. These masses are generally indicated by filaments of metal running through the matrix, whatever it may be, and terminating in a nucleus, the weight and richness of which can never be previously calculated. Such filaments however do not show with certainty that there is any mass to which they lead, for very often they break off and altogether disappoint the anxious adventurer. There is also frequently found in such mines foliated gold, the particles of which much resemble the mica of decomposed granite: these are richer and heavier than the common dust, and of course esteemed a more valuable prize.

In another district, that of Lower Parahybuna, there are extensive supplies of gold in the *caldeiraos* already alluded to. The material in the hollows which the stream has worn in the rocky bottom,

must be nearly free from mixture; for there the water, dashing with violence into the basin, washes the sand which it brings down out again, leaving the heavier and grosser particles at the bottom. For the same reason, the upper strata of the sand in the stiller parts of the river must contain comparatively little of the precious metal, while the lower ones are probably increasing in richness by every circumstance which disturbs the stream. It seems that a cone of wet sand, three feet high, which requires the day's labour of one man to raise, and two days more to wash it, is expected in this part of the country to produce as much gold as is worth from twenty to twenty-five shillings.

Near the brink of one portion of the Parahybuna several canoes lie, which are commonly used in collecting gold-dust from the banks of the stream. By means of a windlass and an iron scoop, the gold-washers dredge up into the canoe a part of the bed of the river; and upon it a stream is conducted by means of large bamboos. The canoes are very large; they are cut out of a solid piece of wood, and are formed externally like a butcher's tray; their inward figure is that of a three-sided prism, one of the edges forming the line of the bottom. There are usually employed three blacks in a canoe, and two on the platform, and three boats will sometimes collect about three-quarters of

an ounce of gold each in the course of a day; but very little is obtained in proportion to the quantity of sand washed, for the metal is not in its natural bed, but brought down thence by the current.

In the remarkable and once rich district of Villa Rica already described, different methods are adopted, the mines being on hill-sides, which are steep. Whenever a natural stream trickles down, its bottom is frequently and carefully searched, particularly when the current has met with any check, for there the precious metal is commonly detained. In parts where nature has provided no water, pits are dug and planked with strong walls or stockades, through which a stream is turned from a distance: the surplus is made to run over the edge of the embankment, and is generally received into a second pit below, sometimes into a third: at proper seasons the pits are cleared of the water; the sediment is taken out and treated in the usual way: the waters are generally saturated with red clay, and by a repetition of these processes, the hill has been stripped of its soil as well as its verdure, wherever a stream can be conducted to carry it away. Numerous drifts also have been run, horizontally, into the softer parts of the mountain until they entirely perforate the coating of schist or clay, and reach its solid core, while the water, oozing through the mass above, is received into

basins, together with the metal which it may convey. The largest quantity is generally found to descend at the end of the shaft or drift, where the soft materials of the mountains rest against the solid ones. These drifts are seldom more than twenty yards long, five feet high, and three broad. Some of the smaller and softer hills of the vicinity have indeed been bored to a much greater extent, and one is completely perforated at its base. Whether large or small, these openings are closed and secured with such precautions as plainly indicate the fear of plunder. A great quantity of the precious metal, there is little doubt, still lies buried around Villa Rica, where it must remain until better methods of mining are adopted.

Independently of the mountains, the streams also about Villa Rica, as they are not private property, are searched for gold. Negroes are always to be seen in the Oiro Preto, or Do Carmo, thus employed. The gold-washers are dressed in a leathern jacket, with a round bowl cut out of the wood of the fig-tree from one to two feet in diameter and one foot deep, and a leathern bag fixed before them; they generally select those places in which the river is not rapid, where it makes a bend and has deep holes. They first remove the large stones and upper layers of sand with their feet or their *gamella*, and then take up a bowlfull from the

deeper and older gravel of the river. They continue to shake, wash, and strike off the stones and sand at the top till the heavy gold-dust appears pure at the bottom of the vessel, on which a little water is thrown in with the hand, and the gold at length put into the leathern bag. This mode of gold-washing is here called *mergulhar*-diving. Every bowl of cascalho, the washing of which requires about a quarter of an hour, generally yields from three-half-pence to three pence, and a man may gain in this manner several shillings in a day. Sometimes the cascalho is washed upon a platform erected on the spot.

The canoes are made in the following manner:— Two ten- or twelve-inch planks, about twelve or fifteen feet in length, are laid on the ground forming an inclined plane, with a fall of six inches from the former. On their sides are boards placed edgeways and staked down to the ground, so as to form long shallow troughs, the bottoms of which are covered with hides, tanned with the hair on, having the hairy side outwards, or, in defect of these, with rough baize. Down the troughs is conveyed the water, containing the oxide of iron, with the lighter particles of gold; the latter substance, precipitating in its course, is caught by the hair. Every half-hour the hides are taken up and carried to a bank near at hand formed of four

walls, say five feet long, four broad, and four deep, and containing about two feet depth of water: the hides are stretched over this tank and well-beaten, then dipped and beaten repeatedly, until all the gold is disentangled, after which they are carried back and replaced in the troughs. The tanks are locked up at night and well-secured. The sediment taken from them, being light, is easily washed away by the hand, in the manner before described, leaving only the black oxide of iron and that part of the gold which is so fine that mercury is used to separate it. About two pounds weight of oxide of iron,—very rich, let it be supposed, in fine grains of gold—are put into a clean bowl, into which two ounces of mercury are also added. The mass of oxide, which is generally very damp, is worked by the hand for about twenty minutes, when the mercury separates from the black oxide of iron and takes up all the gold, assuming a soft doughy mass, that retains any form into which it is squeezed. The grains of gold, however, remain, not amalgamated with, but merely enveloped in the mercury. The mass is put into a folded handkerchief, and an ounce or more of mercury wrung or squeezed from it: the rest is put into a small brass dish, covered with a few green leaves, and then placed over a charcoal fire, where it is stirred with an iron rod to prevent the gold from adhering to the sides of the dish. The leaves are occasion-

ally changed as they become parched by the heat. When taken off, they exhibit in some parts small globules of mercury. On washing them with water, nearly half an ounce of the former substance is usually obtained from them. After this operation the gold is for the most part changed in colour from an agreeable soft yellow to a dirty brown, and presents a very different appearance from that which is not subjected to mercury.

The mode of working the mines of Jaragua is more simple than some of those described, and may be easily explained. Suppose a loose gravel-like stratum of rounded quartzose pebbles and adventitious matter, incumbent on granite, and covered by earthy matter of variable thickness. Where water of sufficiently high level can be commanded, the ground is cut in steps, each twenty or thirty feet wide, two or three broad, and about one deep. Near the bottom, a trench is cut to the depth of two or three feet: on each step stand six or eight negroes, who, as the water flows gently from above, keep the earth continually in motion with shovels, until the whole is reduced to liquid mud and washed below. The particles of gold contained in this earth descend to the trench, where, by reason of their specific gravity, they quickly precipitate. Workmen are continually employed at the trench to remove the stones and clear away the surface, which operation is much

assisted by the current of water which falls into it. After a few days' washing, the precipitation in the trench is carried to some convenient stream to undergo a second clearance. For this purpose wooden bowls are provided, of a funnel shape, about two feet wide at the mouth, and five or six inches deep. Each of the workmen standing in the stream takes into his bowl five or six pounds weight of the sediment, which generally consists of heavy matter, such as granular oxide of iron, pyrites, ferruginous quartz, and often precious stones. They admit certain quantities of water into the bowls, which they move about so dextrously, that the precious metal, separating from the inferior and lighter substances, settles to the bottom and sides of the vessel. They then rinse their bowls in a larger vessel of clean water, leaving the gold in it, and begin again. The washing of each bowlfull occupies from five to eight or nine minutes; the gold produced is extremely variable in quantity and in the size of its particles, some of which are so minute that they float, while others are found as large as peas, and not unfrequently much larger. This operation is superintended by overseers, as the result is of considerable importance. When the whole is finished, the gold is placed over a slow fire to be dried.

It is considered that the tedious process of

washing the cascalho might be much shortened by using a machine of very easy construction: suppose a cylinder, to be formed of bars of iron, longitudinally placed, and nailed to circles of wood, open at each end, and suspended on two centres, one about sixteen inches higher than the other. At the highest end the cascalho is to enter, by being put into a hopper which communicates with it. The bars must be nailed almost close to each other at the upper end, gradually widening to the lower end, where they should be almost half an inch asunder. The cylinder ought to be from ten to twelve feet long, and a stream of water conducted to fall upon it lengthwise; it should be enclosed like a dressing-machine in a flour-mill, and be subjected to a very quick motion. The portion of cascalho containing the most gold will fall through near the upper end; the other parts, according to their comparative fineness, gradually descending until nothing but the pebbles fall out at the lower end; the earth, &c., falling into partitions or troughs below the cylinder, would be ready for being separated from the gold by hand, which might be done with very little trouble. Machines of this kind might be made on any scale, and if generally known and adopted, would save human labour to a very great extent. A further improvement might be made, too, in this useful

apparatus; for if the gold washed from the machine were to fall upon troughs placed in an inclined position, having a channel across about a yard from the upper end, all the gold would precipitate into it; and if a man were to be continually employed in agitating the water, the earthy matter would run off, leaving only the gold and the ferruginous particles, which might be separated by mercury.

The only miners' tools employed in Brazil up to a recent period were the iron-bar and the hoe, but the common miner's pick would in many cases be serviceable; and *bucking-irons** would reduce the matrix much more effectually than beating it with stones, which is the usual mode now practised; and, in many instances, hand-sieves, if not too costly, would be found extremely useful, and would certainly save considerable time and labour in washing.

Mills composed of heavy irregular stones, resembling those used in England for grinding flints, would be useful in reducing many of the ferruginous masses and softer substances which contain gold; whilst *stamps* might be employed where the gold is found in hard and brittle substances; or

* Bucking-irons are pieces of cast-iron, with wooden handles, used at the lead-mines in Britain, to break the ore from what it adheres to.

these would be perhaps as effectually, though more expensively, pulverized by a heavy stone rolling on its edge and worked by men*.

The mining operations in California are, as may be supposed, on a somewhat rude scale at present, and there cannot be a shadow of doubt that large quantities are allowed to escape the washings. These however will not travel far, and may reward, though in a smaller degree, those who carry on operations after the first fever of gold-seeking has passed away. A good idea will be formed of present proceedings by the following extract from Colonel Mason's despatch:—"The day was intensely hot, yet about 200 men were at work in the full glare of the sun, washing for gold—some with tin pans, some with close-wove Indian baskets; but the greater part had a rude machine, known as the cradle. This is on rockers, six or eight feet long, open at the foot, and at its head has a coarse grate, or sieve: the bottom is rounded with small cleets nailed across. Four men are required to work this machine: one digs the ground in the bank close by the stream; another carries it to the cradle, and empties it on the grate; a third gives a violent rocking motion to the machine,

* Iron cylinders hardened at the surface by sudden cooling are used in Cornwall in crushing tin ores, and might be very useful if available.

whilst a fourth dashes on water from the stream itself.

"The sieve keeps the coarse stones from entering the cradle, the current of water washes off the earthy matter, and the gravel is gradually carried out at the foot of the machine, leaving the gold mixed with a heavy fine black sand above the first cleets. The sand and gold mixed together are then drawn off through auger-holes into a pan below, are dried in the sun, and afterwards separated by blowing off the sand. A party of four men thus employed at the lower mines averaged 100 dollars a day. The Indians, and those who have nothing but pans or willow-baskets, gradually wash out the earth and separate the gravel by hand, leaving nothing but the gold mixed with sand, which is separated in the manner before described. The gold in the lower mines is in fine bright scales, of which I send several specimens."

Another scene is described as follows; it is from the despatch forwarded to head-quarters at Washington by Mr. Larkin, dated 28th June:—

"A person without a machine, after digging off one or two feet of the upper ground, near the water (in some cases they take the top earth), throws into a tin pan or wooden bowl a shovelfull of loose dirt and stones; then placing the basin an inch or two under water, continues to stir up

the dirt with his hand in such a manner that the running water will carry off the light earths, occasionally with his hand throwing out the stones; after an operation of this kind for twenty or thirty minutes, a spoonful of small black sand remains; this is placed on a handkerchief or cloth and dried in the sun, and the loose sand being blown off, the pure gold remains."

In spite however of the roughness of the treatment, the results are such as to astonish every one accustomed only to the present workings in other parts of South America. Some of these have been already mentioned, and we are also told, that in the side valleys "two ounces of gold is considered an ordinary yield for a day's work," and that "a small gutter a hundred yards long by four feet wide, and two or three deep, had yielded gold to the value of 17,000 dollars," (probably about 1000 ounces). For this latter result it appears that four white men and about 100 Indians had been employed for one week! These statements are given upon the authority of Colonel Mason, who adds, that there are hundreds of small ravines of similar appearance still untouched.

We have already alluded to the tools used in the Brazilian mines, and have seen that they are sufficiently simple; those employed in California, up to the present time, have been however much

coarser, and even less adapted to the exigences of the case. An account of a few simple contrivances that would be found useful, and may be easily obtained, or conveyed by emigrants, will form an appropriate conclusion to the present chapter.

The iron-bar, the pick and the shovel*, are all the tools that can well be needed to raise the alluvial soil that seems to be so amply supplied with the precious metal. The chief operation requiring mechanical ingenuity is therefore the *washing*, or removing the useless soil, and this may be done either before or after the reduction of the whole mass to powder. No doubt, where the gold is in tolerably large lumps, the former is the more productive, because less time is wasted; but nearer the mouths of the streams, and in that material which has already been coarsely sifted, there will remain a large quantity of very rich produce, that can only be obtained by pounding as well as washing.

The following method is adopted in Chili to reduce auriferous detritus to a fit state for washing:—"A streamlet of water conveyed to the hut of the gold-washer is received upon a large, rude stone, whose flat surface has been hollowed out into a shallow basin, and in the same manner into

* The miner's form of the shovel is the best, consisting of a simple pan of a conical form.

three or four others in succession; the auriferous particles are thus allowed to deposit themselves in these receptacles, while the lighter earthy atoms, still suspended, are carried off by the running water. The gold thus collected is mixed with a quantity of ferruginous black sand and stony matter, which requires the process of trituration. This is effected by a very rude and simple grinding apparatus consisting of two stones, the under one being about three feet in diameter and slightly concave. The upper stone is a large spherical boulder of granite about two feet in diameter, having on its upper part two iron plugs fixed opposite each other, to which is secured, by lashings of hide, a transverse horizontal pole of wood about ten feet long; two men, seated on the extremities of this lever, work it up and down alternately, so as to give to the stone a rolling motion, sufficient to crush and grind the materials placed beneath it. The washings thus ground are subjected to the action of running water, upon inclined planes formed of skins, by which process the siliceous particles are carried off, while a portion of the ferruginous matter, mixed with the heavier grains of gold, is extracted by a loadstone; it is again washed till nothing but pure gold-dust remains. The whole process is managed with much dexterity; and if there were much gold to

be separated, it would afford very profitable employment; but generally the small quantity collected is sufficient only to afford subsistence to a few miserable families."

The mechanical ingenuity of the men of Anglo-Saxon race who are now so energetically employed in California, will soon find some simple and ingenious contrivance of the above kind, or at least answering the same purpose; and the one described is chiefly alluded to in order to show how exceedingly simple the machinery is that will at any rate answer the purpose of separating gold from the accompanying soil and rock. More elaborate contrivances, moved by horse-power or by water, would however amply repay the cost and labour of erection, and the following account of the mechanical contrivances in use in England and other mining countries will, perhaps, suggest useful hints, even if the methods are not exactly copied.

The instruments for preparing ore in most mining districts are principally stamping-mills, or *stamps* as they are called, crushing-mills or grinders, and jigging-machines. The former are of various dimensions and power; they are usually driven by water-wheels, and are generally sufficiently simple in their construction. They consist of sets of pestles working up and down within a box or trough open behind, to admit the ore which

slips in under the pestles, being carried along by a stream of water falling over an inclined plane. Each pestle is of wood, measuring about six inches by five in the square, and of convenient length. Each also carries a lifting-bar secured with a wooden wedge and iron bolt, and each terminates below in a lump of cast-iron called the head, which is fastened to it by a tail, and weighs about 2½cwt. The shank of the pestle is strengthened with iron hoops. A turning shaft is so arranged as to communicate motion by cams placed round its circumference, lifting the pestles in succession by their lifting-bars, and then allowing them to fall through a space of eight or ten inches. They are arranged in such a way in the trough, that one falls while the others are uplifted. There may be four cams for each pestle, and about seven revolutions of the shaft per minute, giving, therefore, twenty-eight stamps per minute from each pestle. Two sets of three or four pestles each, and the trough in which they work, is called a *battery*, and a battery of six pestles will pound about sixty cubic feet of the ordinary tin stuff of Cornwall (weighing perhaps four or five tons) in twelve hours.

In front of the troughs there are openings fitted with an iron frame, the openings measuring about eight inches square. This frame is closed with sheet-iron, bored conically with about 160

holes in the square inch, the narrow side of the hole being towards the inside. The ore passing out by these holes is received into basins, where it is separated by water into several kinds of mud afterwards sifted.

The crushing-mill or grinder consists of one or more pairs of iron rollers placed a very short distance apart, and kept in motion either by the direct action of a water-wheel or by cog-wheels attached to it. Immediately above the rollers is a hopper, into which the lumps to be crushed are thrown, when, falling through between the rollers, they are completely broken into small fragments. In some crushing-mills there are two or three pairs of rollers, those below being placed very near together, so as to reduce the stuff falling from above still finer; and by an ingenious application of sieves kept in motion by the machine, the stuff can be sorted into two or three different sizes. Although by passing through the crushing-mill, the material has been reduced to very small fragments, it is not all sorted; but in the next process, by the jigging-machine or 'break-sieve,' this is done to a considerable extent.

The jigging-machine consists of a wooden frame, open at the top, and provided with a strong screen or iron grating at the bottom: it hangs over a cistern of water, being suspended to a long lever,

the motion of which alternately plunges it into the water, and raises it out with a peculiar jerk each time. The ores being placed in the sieve and subjected for a short time to this operation, the heavy metallic pieces settle at the bottom, while the lighter fragments of spar and veinstone are thrown to the top, and every now and then very dextrously skimmed off with a piece of board by a man who stands by. In the operation of jigging, a very important separation is effected, as three products are obtained by it: the small rich particles which pass through the sieve into the cistern below, and are removed occasionally as may be necessary; the larger rich fragments which occupy the bottom of the cistern; and the poor earthy matter which forms a layer at the top. This last product, although poor, still contains too much metal to be lost: it consists of small fragments of rock or veinstone, many of which have small particles of metal, either attached to them or intermixed with them, and to any eye but that of the miner's would appear quite worthless, no less from the small quantity of the ore than the manifest difficulty of separating it from such a mass of stony matter.

To extract the ore from this refuse-matter, several processes are used, which are chiefly grinding between rollers placed very close to each

other, stamping to a fine powder by the stamping-mill, and finally, washing upon an inclined plane. In this operation, the fine metallic mud or 'slime' being carefully spread over the inclined plane at the upper end, a gentle stream of water is allowed to flow over it, which washes the light earthy particles towards the bottom, leaving the heavier metallic ones in a very pure state towards the top. As in this process, and indeed all other operations of dressing in which a stream of water is employed, many of the smallest and most minute particles of the ore are carried away, the waste of which, in an extensive mine, would be considerable, it is arranged that all such water shall pass into successive reservoirs, termed 'slime-pits,' in which the metallic particles fall to the bottom, and are from time to time collected and subjected to such treatment as to obtain them in a tolerably pure state.

The operations above described are chiefly applicable, it is true, to such ores as are less valuable than the alluvial gold deposits at present worked in California. They give, however, a general idea of the kind of work that is needed, and explain in what way, and to what extent, mechanical operations are available in bringing valuable materials into a state in which their value is most considerable.

CHAPTER VII.

THE ASSAY, REDUCTION, REFINEMENT, AND RELATIVE VALUE OF GOLD.

It is not intended here to enlarge on the metallurgical treatment even of alluvial gold, as such treatment is rarely adopted by the first finders of this precious metal; still less shall we dwell on the processes by which gold is separated from auriferous ores of silver and other metals by the refined methods of amalgamation adopted in Mexico, Brazil and Germany. These latter processes have lately been described by M. Duport in detail, as far as Mexico is concerned, and had before been described as they are practised in Germany. We mention however M. Duport's work as one not unlikely to be useful in future operations in California, for it would seem that gold is by no means the only metal there found, silver-mines (no doubt auriferous) existing in the same district; and mines of mercury having not only been found, but actually worked, within little more than a hundred miles of the gold district. The circumstances connected with these quicksilver-mines are so important, and so intimately connected with the value of the

district as a gold-producing country, that we have no hesitation in quoting once more from Col. Mason's despatch the following interesting account of some works that have been carried on near San Francisco within a very recent period, and that were actually in progress at the time of his visit in September last.

"Before leaving the subject of mines, I will mention, that on my return from the Sacramento I touched at New Almoder, the quicksilver-mine of Mr. Alexander Forbes, Consul of Her Britannic Majesty at Tepic. This mine is in a spur of the mountains 1000 feet above the level of the bay of San Francisco, and is distant in a southern direction from the Puebla de San José about twelve miles*. The ore (cinnabar) occurs in a large vein dipping at a strong angle to the horizon. Mexican miners are employed in working it, by driving shafts and galleries about six feet by seven following the vein.

"The fragments of rock and ore are removed on the backs of Indians in raw hide sacks. The ore is then hauled in an ox-wagon from the mouth of the mine down to a valley well-supplied with wood and water, in which the furnaces are situated. The furnaces are of the simplest construction—

* The distance from San Francisco would appear to be less than fifty miles.

exactly like a common bake-oven, in the crown of which is inserted a whaler's frying-kettle; another inverted kettle forms the lid. From a hole in the lid a small brick channel leads to an apartment or chamber, in the bottom of which is inserted a small iron kettle. The chamber has a chimney.

"In the morning of each day the kettles are filled with the mineral (broken in small pieces) mixed with lime; fire is then applied and kept up all day. The mercury is volatilized, passes into the chamber, is condensed on the sides and bottom of the chamber, and flows into the pot prepared for it. No water is used to condense the mercury.

"During a visit I made last spring, four such ovens were in operation, and yielded in the two days I was there 656 pounds of quicksilver. Mr. Walkinshaw, the gentleman now in charge of this mine, tells me that the vein is improving, and that he can afford to keep his people employed even in these extraordinary times. The mine is very valuable of itself, and will become the more so as mercury is extensively used in obtaining gold. It is not at present used in California for that purpose, but will be at some future time. When I was at this mine last spring, other parties were engaged in searching for veins; but none have been discovered worth following up, although the

earth in that whole range of hills is highly discoloured, indicating the presence of this ore. I send several beautiful specimens, properly labelled. The amount of quicksilver in Mr. Forbes's vats, on the 15th July, was about 2500 pounds."

We proceed now to describe the more simple and practicable modes of obtaining gold, and give as the first example a method of treatment by which the reduction was effected in a rough way, with very simple means, some years ago at Villa Rica in Brazil. In this case the gold obtained was from washings, and in the form of fine grains or dust. This gold-dust is described as being "put into a crucible of proportionate size, and, as soon as it begins to melt, is kept there for some time with sublimate of mercury. When it appears to be perfectly melted, the metal is poured into a square iron mould furnished with handles, in which it cools. These moulds are of very different sizes, containing from half an ounce to 28 lbs. weight avoirdupois of gold. The various combinations of the gold to be melted with iron, antimony, manganese or arsenic, determine the time necessary to melt it. Gold which is more difficult to melt is mixed with a greater proportion of sublimate; this is particularly the case with that with which much iron is mingled; the workmen, by long experience, generally know the

quantity of the addition which the gold of such mines requires. Very pure gold is perfectly melted in three hours. The colour of the gold smelted at Villa Rica is of very different hues, from the most beautiful gold-yellow to reddish copper colour, bright yellow, and even gray-yellow—a specimen of every shade is preserved. The gold bar, when cut, comes into the hands of the assayer, who determines the weight and fineness by the trial with sublimate:—for this purpose, he takes a piece from one end of the bar, and in difficult cases from both. In bars from well-known mines, the trial is made only with the touchstone, for which are kept, on copper pins, the specimens from 16 to 24 carats (75 per cent. to fine gold), each of which is divided into eight equal parts. The purest gold smelted at Villa Rica is of 23 carats and seven-eighths. The mines of Villa Rica generally produce gold from 20 to 23 carats; those of Sabará and Congonhas de Sabará, from 18 to 19 carats; that from the Rio das Velhas near Sabará gives from 19 to 20. The gold of Cocaës and Inficionado is very pure, though not of a very fine yellow, but often pale or copper-coloured."

We come next to consider the ordinary methods of assay for gold, which must be conducted in reference to the nature of the metal with which it is alloyed.

As the simplest mode of assay, and yet one which seems admirably adapted to obtain accurate results, we will first describe a method lately introduced by Professor G. Rose of Berlin. This chemist fuses the gold-dust with three times its weight of pure lead (obtained by igniting the sugar of lead of commerce). Treating the alloy obtained by nitric acid, the gold is left behind, the lead, copper, silver, &c. being dissolved in the nitric acid. The gold is afterwards washed, dried, and weighed.

We next describe the older and more usual treatment:—When gold is alloyed with copper or silver, the mode of assay for separating the copper depends on the process of cupellation, and that for separating the silver, on the power of nitric acid to dissolve silver without acting on the gold.

The process of cupellation consists in heating the assay in a small cup (called a cupel) made of bone-ashes (or in a cavity containing bone-ashes), while the atmosphere has free access. The heated metal is oxidated by the air passing over it, and the oxide formed sinks into the porous cup, leaving the precious metal behind. In order to fuse the alloy and still have the atmosphere circulating over it, the cupel is placed in a small oven-shaped vessel, called a muffle, made of infusible stone-ware, and having a number of oblong holes through

which to admit the flame from the fire, and give exit to the atmosphere which passes into it. The muffle is inserted in a hole fitting it in the side of a vertical furnace, with the open mouth outward and nearly even with the exterior surface of the furnace. The fire is made within the furnace, below, around, and above; and after heating up, the cupel is put in the muffle with the assay in its shallow cup-shaped cavity. It thus has the heat of the furnace to fuse the assay, and the air at the same time is drawn in over it through the large opening of the muffle. The oxygen of the atmosphere unites with the lead of the assay and produces an oxide which sinks into the cupel, leaving the silver or gold behind. The completion of the process is at once known by the change of the assay suddenly to a bright shining globule.

In the cupellation of gold containing copper, lead is melted with the assay. The lead on being fused in a draft of air oxidizes, and also promotes the oxidation of the copper, and both oxides disappear in the pores of the cupel, leaving the gold behind and the silver alloyed with it. In this process the gold is melted with three times its weight of silver, (a quartation as it is termed, the gold being one part out of four of the alloy,) in order by its diffusion to effect a more complete removal of the silver as well as the contained copper. The

cupel is placed in the heated furnace, and the gold, silver and lead on the cupel; the heat is continued until the surface of the metal is quiet and bright, when the cupellation is finished; the metal then is slowly cooled and removed. The button obtained after annealing it by bringing it to a red heat, is rolled out into a thin plate and boiled in strong nitric acid. This process is repeated two or three times with a change of the acid each time, and the silver is thus finally removed. The quantity of metal submitted to this process is very small, often not exceeding eight grains, and the assay gold and quartation silver are wrapped in a sheet of lead, weighing about ten times as much as the gold under assay. After cupellation, the plate of gold and silver loosely rolled into a coil, is boiled for twenty minutes in four and a quarter ounces of nitric acid of 20° to 22° Beaumé; the acid is then poured off and another portion of stronger acid is added (about half the former quantity), and boiled ten minutes; then the same again. The gold thus purified is washed and exposed to a red heat for the purpose of drying and annealing it, and then weighed.

As a convenient mode of effecting an assay of gold-dust of tolerable purity, and where either silver or platina is present (in which case cupellation is not directly applicable), a given weight

of the dust (say 100 grains) may be digested with aqua regia (nitro-hydrochloric acid), and the solution being precipitated with protosulphate of iron and fused with nitre and borax, the residue is the gold contained. The silver in this case will remain on the filter in the form of a white powder (chloride), and the platina may be precipitated by hydrochlorate of ammonia.

The reduction of gold ores is effected either by amalgamation with mercury or by fusion with lime and a flux—the former being the method usually adopted when the ores contain a fair proportion of native gold, and the latter in the case of auriferous pyrites. Amalgamation, in the former case, is thus performed:—

The ore, having been pounded fine, is washed, to separate as much of the light stony matter as possible, which is done either with a machine called a sweep-washer, or more simply by placing the pounded ore in a shallow vessel with two handles, which, when immersed in a tub of water or running stream, and a kind of rotatory motion applied, separates the lighter from the heavier particles. The residue left from the washing is to be dried and mixed with a sufficient quantity of mercury to amalgamate the gold and silver contained; to favour which, a gentle heat may be applied to the mass for two or three days, at the

end of which the fluid amalgam is to be poured off and pressed in a skin of leather; this will separate a considerable part of the mercury, which is again applied to the same purpose: the gold is now left in an impure state in the retort, and may be purified by cupellation or quartation, as described in the method of assaying. The rest of the mercury is obtained from the skin by distillation.

The method of amalgamation is however much modified when the ore is very argentiferous, but in that case the treatment belongs rather to the metallurgy of silver than of gold ores, and any detailed description would be out of place here.

The processes for refining gold, or removing entirely the copper, silver and other metals that interfere with its malleability and ductility, are also unnecessary to be detailed here. Nitric acid is the chief means resorted to for this purpose, the refiner taking advantage of the fact that silver is dissolved by this acid, whereas gold is not affected by it; but the method is only available when the weight of the silver is at least double that of the gold. It has been found also of late years that the use of sulphuric acid offers advantages over that of nitric, but that to produce the best result it is advisable to have the metals in the following proportions; silver 725, gold 200, copper 75, to which the alloy to be refined requires to be re-

duced before the operation is commenced. It may be worth while to know this in the management of gold ores.

The purity and therefore the value of gold is also sometimes determined by observing the colour and appearance of the streak or mark it leaves on a hard smooth stone, generally what is called Lydian stone or flinty jasper by mineralogists, but known to jewellers as the *touchstone*. This method is of course not to be depended on too much, but when the ordinary chemical tests of the blowpipe and acids are combined with it, it forms a useful guide in practice.

The fineness of gold is usually estimated in *carats*, the perfectly pure metal being called *fine*, and reckoned as 'twenty-four carats,' and that which is less pure as so many 'carats fine,' as it has a twenty-fourth part pure. Thus English standard gold is said to be 'twenty-two carats fine,' consisting of twenty-two parts pure gold, and two parts alloy (either silver or copper, and without regard to the nature of the alloy). So also gold is said to be twenty carats fine when the proportion of alloy is one-sixth, or twenty parts fine gold and four parts alloy.

The carat is subdivided into quarter, eighth, sixteenth and thirty-second parts for more minute specification; and carats are either real or propor-

tional, the carat however being rarely used now as an actual weight.

The value of gold in England is fixed by Act of Parliament, gold being the standard of money value, and the sovereign containing 123·274 grains troy of gold, 22 carats fine, and therefore 113·001 grains troy of pure gold. The sovereign is equivalent to twenty shillings, each shilling containing 87·2727 grains troy of standard silver and 80·727 grains of pure silver. Thus the ratio of gold to silver in England is invariable, being $14\frac{2}{7} : 1$ nearly, or more accurately 14·28784 : 1. Hence it results that the ounce troy (consisting of 480 grains) of fine gold is worth 4*l.* 4*s.* $11\frac{1}{4}\frac{5}{6}$*d.* nearly; but the value of the ounce of standard gold, being one-twelfth less, amounts to 3*l.* 17*s.* $10\frac{1}{2}$*d.*

It may be useful to mention here the value of gold in other countries in Europe and America.

In France the napoleon (value twenty French francs) weighs 99·564 grains, of which 89·61 are pure gold.

In Spain, the pistole or doubloon of four crowns of 1786 weighs 208·755 grains, and is worth 1*l.* 12*s.* $4\frac{1}{4}\frac{1}{2}$*d.* The old doubloon is of the same weight but different standard, being worth 1*l.* 13*s.* 3*d.*

In Holland the ten-florin piece, now a current gold coin, weighs 103·88 grains, and is worth 16*s.* $6\frac{3}{4}$*d.*

In the United States of America the eagle of ten dollars weighs 269·85 grains, of which 232 are fine gold. The value in English money is 2*l.* 3*s.* $10\frac{1}{8}\frac{1}{4}$*d.* The standard in the United States is nine parts gold to one of alloy, or $21\frac{1}{2}\frac{1}{10}$ carats fine, being therefore two-fifths of a carat lower than England.

In the preceding pages we have preferred estimating weight in the avoirdupois method, as being more familiar. The ounce avoirdupois is equal to $437\frac{1}{2}$ grains troy, and the pound avoirdupois to 7000 grains troy, or 1 lb. 2 oz. 280 grains (the pound troy consisting of 12 ounces). The lamentable complication and confusion in the system of English weights renders tables and calculations on this subject far more tiresome and difficult to comprehend than there is the slightest necessity for, but the expressions here given will be found useful.

It may be useful also sometimes, in estimating the value of gold in bullion, to know that the pound avoirdupois of fine gold is worth 61*l.* 18*s.* 11*d.* The pound troy of standard gold is coined into $46\frac{89}{1\,2\,0}$ths sovereigns, or £46 14*s.* 6*d.*, which is therefore the value of the pound troy weight.

CHAPTER VIII.

PROBABLE INFLUENCE OF THE GOLD OF CALIFORNIA ON THE COMMERCIAL VALUE OF GOLD.

Gold being a metal highly indestructible, and, owing to its comparative rarity and the many uses to which it can be applied, exceedingly valuable, has been made use of in most parts of the world as a medium of exchange; and in order, as it was supposed, to facilitate commercial operations and simplify many calculations of national importance, has been taken with silver as the standard of money value. In our own country (as has been just explained) the relative value of gold and silver is fixed by law, gold being a legal tender, and silver coins bearing a fixed ratio to gold.

Gold and silver, however, although their value is thus fixed, so far as they have reference to coins in our own country, are, like all objects of value that exist in nature and are obtained from the earth by an expenditure of labour, subject to great fluctuations in real value, as a larger or smaller quantity of them happens to be in the market. Up to the present time, nothing that has occurred since the year 1816 (when the standard values

were fixed by Act of Parliament, and gold made a legal tender for all sums above 40*s*.) has so far deranged the relative values of the precious metals as to produce inconvenience; but it is manifest that any permanent increase in the supply of either would alter their relative values, and render the present standard inapplicable.

The meaning of this may be made more clear by a simple example. The annual income of Great Britain amounts to a certain number of millions of pounds sterling, say fifty-six millions, and this under present circumstances would be represented by somewhat more than nine hundred thousand pounds weight avoirdupois of fine gold. But this income might also be paid by about thirteen millions of pounds weight of pure silver, if silver were a legal standard, or if the silver were employed to purchase in the market its value in gold. Now if we suppose the quantity of available gold doubled without that of the silver being perceptibly increased, the proportionate value of gold and silver in the world must be altered to a great extent, and the required weight of gold purchasable for a smaller quantity of silver than thirteen millions of pounds, since the relative value of the metals in other countries than our own depends to some extent (although as we shall presently see not entirely) on the quantities of the two substances in

the market, and the value of both compared with that of food and labour.

As however the whole subject of the value of the precious metals is frequently very ill understood by those whom notwithstanding it greatly concerns, it will be worth while here to place it distinctly before the reader; and as I am not aware that any writer on the subject has done so with a more distinct perception of the state of the case than Dr. Adam Smith, I make no apology for offering the following extracts from his work on the Wealth of Nations:—

"The value of any commodity, to the person who possesses it, and who means not to use or consume it himself, but to exchange it for other commodities, is equal to the quantity of labour which it enables him to purchase or command. Labour, therefore, is the real measure of the exchangeable value of all commodities.

"But though labour be the measure of this value, it is not that by which their value is commonly estimated. It is often difficult to ascertain the proportion between two different quantities of labour, and the time spent in two different sorts of work will not always alone determine this proportion. It is more natural therefore to estimate its exchangeable value by the quantity of some other commodity than by that of the labour which it can

produce; and hence also it comes to pass that the exchangeable value of every commodity is more frequently estimated by the quantity of *money* than by the quantity either of labour or of any other commodity which can be had in exchange for it.

"Gold and silver, however, like every other commodity, vary in their value, being sometimes cheaper and sometimes dearer, sometimes of easier and sometimes of more difficult purchase. The quantity of labour which any particular quantity of them can purchase or command, or the quantity of other goods which it will exchange for, depends always upon the fertility or barrenness of the mines which happen to be known about the time when such exchanges are made. The discovery of the abundant mines of America reduced in the sixteenth century the value of gold and silver in Europe to about a third of what it had been before. As it cost less labour to bring those metals from the mine to the market, so, when they were brought thither, they could purchase or command less labour; and this revolution in their value, though perhaps the greatest, is by no means the only one of which history gives some account.

"Now although it is true that at distant places there is no regular proportion between the real and the money price of commodities, yet the merchant who carries goods from the one to the other has

nothing to consider but the money price, or the difference between the quantity of silver or gold for which he buys them, and that for which he is likely to sell them. Half an ounce of silver at Canton in China may command a greater quantity both of labour and of the necessaries and conveniences of life than an ounce at London. If a London merchant, however, can buy at Canton for half an ounce of silver a commodity which he can afterwards sell at London for an ounce, he gains a hundred per cent by the bargain, just as much as if an ounce of silver was at London exactly of the same value as at Canton. An ounce at London will always give him the command of double the quantity of all these, which half an ounce could have done there, and this is precisely what he wants.

"In reality, during the continuance of any one regulated proportion between the respective values of the different metals in coin, the value of the most precious metal regulates the value of the whole coin. Twelve copper pence contain half a pound avoirdupois of copper, of not the best quality, which before it is coined is seldom worth seven pence in silver. But as, by the regulation, twelve such pence are ordered to exchange for a shilling, they are in the market considered as worth a shilling, and a shilling can at any time be had for them.

"The occasional fluctuations in the market price of gold and silver bullion arise from the same causes as the like fluctuations in that of all other commodities. The frequent loss of those metals from various accidents by sea and by land, the continual waste of them in gilding and plating, in lace and embroidery, in the wear and tear of coin, and in that of plate, require, in all countries which possess no mines of their own, a continual importation in order to repair this loss and this waste. The merchant-importers, like all other merchants, we may believe, endeavour as well as they can to suit their occasional importations to what they judge is likely to be the immediate demand. With all their attention, however, they sometimes overdo the business, and sometimes underdo it. When they import more bullion than is wanted, rather than incur the risk and trouble of exporting it again, they are sometimes willing to sell a part of it for something less than the ordinary or average price. But when, under all those occasional fluctuations, the market price either of gold or silver bullion continues for several years together steadily and constantly either more or less above or more or less below the Mint price, we may be assured that this steady and constant, either superiority or inferiority of price, is the effect of something in the state of the coin, which at that time renders a

certain quantity of coin either of more value or of less value than the precise quantity of bullion which it ought to contain. The constancy and steadiness of the effect suppose a proportionable constancy and steadiness in the cause.

"The money of any particular country is, at any particular time and place, more or less an accurate measure or value, according as the current coin is more or less exactly agreeable to its standard, or contains more or less exactly the precise quantity of pure gold or pure silver which it ought to contain."

We now give one more extract from the same great authority in illustration of the important but ill-understood principle, that the true revenue of society consists *altogether* in the goods possessed, not in the money itself, which he compares to the wheel which circulates them :—

"It is the ambiguity of language only which can make this proposition appear either doubtful or paradoxical. When properly explained and understood, it is almost self-evident.

"When we talk of any particular sum of money, we sometimes mean nothing but the metal pieces of which it is composed, and sometimes we include in our meaning some obscure reference to the goods which can be had in exchange for it, or to the power of purchasing which the possession of it

conveys. Thus, when we say that the circulating money of England has been computed at eighteen millions, we only mean to express the amount of the metal pieces which some writers have computed, or rather have supposed to circulate in that country. But when we say that a man is worth £50 or £100 a-year, we mean commonly to express not only the amount of the metal pieces which are annually paid to him, but the value of the goods which he can annually purchase or consume; we mean commonly to ascertain what is or ought to be his way of living, or the quantity and quality of the necessaries and conveniences of life in which he can with propriety indulge himself.

"When by any particular sum of money we mean not only to express the amount of the metal pieces of which it is composed, but to include in its signification some obscure reference to the goods which can be had in exchange for them; the wealth or revenue which it in this case denotes, is equal only to one of the two values which are thus intimated somewhat ambiguously by the same word, and to the latter more properly than to the former, to the money's worth more properly than to the money.

"Thus, if a guinea be the weekly pension of a particular person, he can in the course of the week purchase with it a certain quantity of subsistence,

conveniences and amusements. In proportion as this quantity is great or small so are his real riches, his real weekly revenue. His weekly revenue is certainly not equal both to the guinea and to what can be purchased with it, but only to one or other of those two equal values, and to the latter more properly than to the former, to the guinea's worth rather than to the guinea.

"If the pension of such a person was paid to him, not in gold but in a weekly bill for a guinea, his revenue surely would not so properly consist in the piece of paper as in what he could get for it. A guinea may be considered as a bill for a certain quantity of necessaries and conveniences upon all the tradesmen in the neighbourhood. The revenue of the person to whom it is paid does not so properly consist in the piece of gold as in what he can get for it, or in what he can exchange it for. If it could be exchanged for nothing, it would, like a bill upon a bankrupt, be of no more value than the most useless piece of paper.

"Money, therefore, the great wheel of circulation, the great instrument of commerce, like all other instruments of trade, though it makes a part, and a very valuable part of the capital, makes no part of the revenue of the society to which it belongs; and though the metal pieces of which it is composed, in the course of their annual

circulation, distribute to every man the revenue which properly belongs to him, they make themselves no part of that revenue*."

Having thus by a few extracts from the great authority in political economy brought before the reader the true nature of money, both as a source of revenue and a circulating medium, we may proceed to the main object of this chapter, namely, to show the probable influence of a large increase in the stock of gold poured annually into the metal market.

There can of course be no doubt that the influx, whether sudden or gradual, of so large a quantity of either of the precious metals as to affect manifestly either the prices of goods or the relative value these metals at present bear to each other, would, in the case of England, have a distinct influence on the standards of gold and silver. It becomes therefore important to consider, at a very early stage of any possible change of this kind, what increase is likely to take place, and what would be sufficient to produce a really perceptible result. If it appear that the supplies from California threaten any such result, it might be advisable to meet the evil and make arrangements in time—a matter that could probably be done without much difficulty; but if it appear from a

* Smith's Wealth of Nations, *ante cit.*

fair calculation that no such mischance is likely to happen, we may let events take their course quietly, and watch with interest, but without fear, the development of the resources now suddenly made available.

An interesting question that must be discussed here is the probable total annual supply of gold and silver throughout the world, as well now and within the last fifty years, as for the 300 years that have elapsed between the discovery of America and the commencement of the present century.

It is true that very rough estimates must suffice for many of these points, and possibly information exists that would give much more accurate results than any that will be here offered; but such information is not at the moment attainable by the author, and the general conclusion would not, he believes, be affected by it.

The supplies of the precious metals received from the various parts of the world, described in former pages, vary exceedingly in amount in different years, so that it is difficult to obtain any average without taking into account a large number of years. It appears from calculations made at the beginning of this century by Humboldt, that the quantity actually extracted from the South American mines, from the discovery of the New World to the year 1803, a period of nearly three

the middle of the last century the ounce of gold became worth fourteen to fifteen ounces of silver, and is now fixed at $14\frac{7}{24}$ ounces nearly, or about equal to that which obtained in ancient Greece*. The discovery of America, therefore, and the influx of the precious metals to the extent of upwards of fifteen hundred millions sterling, in addition to the regular sources of supply and the accumulations in Europe to that period (the quantity of the two metals being in the proportion of fifty-one ounces of silver for each ounce of gold, and the value, as we have said, from ten to fifteen ounces of silver for one of gold), trebled the money value of labour and corn; but in spite of the enormously larger proportion of silver introduced, it has increased the value of gold by only one-fifth part†,

* More accurately 14·2878; the shilling being fixed at 80·727 grains fine silver, and the sovereign at 113·001 fine gold. We have therefore the ratio $= \frac{80{\cdot}727 \times 20}{113{\cdot}001} = \frac{1614540}{113001} = 14{\cdot}2878.$

† In a work published in 1807, it was estimated that the value of the gold and silver together brought into circulation was then about £10,000,000, and of this quantity about three-quarters of a million was probably gold and the rest silver. This agrees with the estimate made by other authors, that about one-fourth part of the whole supply affects the circulation. It may therefore be some guide in future calculations.

The differences above referred to have as yet induced no corresponding change in the standard, nor has such a change been rendered necessary in the smallest degree. The precious metals still flow into and from our country, according to the

owing no doubt to the far larger use of silver in the arts, partly consequent upon its greater abundance.

It is considered by those who have made careful calculations on this subject, that the average annual supply of gold for some years past must have exceeded five millions sterling, that of silver amounting to eight millions or thereabouts; and that while the supply of silver has been for some years increasing with some degree of regularity, that of gold has also increased, but chiefly within a few years. The latter supposition, there can be no doubt, is true, as the evidence already given with regard to the supply from the Ural and Siberia abundantly proves; and it has indeed at present amounted to this, that each ounce of gold has latterly been balanced by only thirty ounces of silver, instead of fifty, as had been the case for some years previously; the value of the whole of the silver introduced being thus double that of the gold, though formerly it was treble.

Are there however, it may be asked, no necessary bounds set to this absorption of a material which, like gold, is of limited use in the arts? Perhaps the best answer will be given by comparing the

course of exchange and the general value of gold as affected by local and temporary causes; so that, although the quantity of gold has been so vastly increased by recent importations from Siberia, some outlet must have been found to prevent the change from being seen or felt.

following table, carefully made by Humboldt, with the relative values of gold and silver in the world within the period of the last three centuries.

Proportionate Supply of Gold from America.

Periods.	Average annual importation of gold and silver from America.	Remarks.
	£	
1492–1500.	53,750	Till 1525 gold chiefly produced, after that silver almost exclusively.
1500–1545.	645,000	
1545–1600.	2,365,000	Silver very largely predominating.
1600–1700.	3,546,000	Potosi mines exhausted after the middle of the century.
1700–1750.	4,837,500	Brazilian gold-mines wrought and very large quantities of gold introduced.
1750–1803.	7,589,500	Brazilian gold-mines alone estimated to produce gold to the annual value of one and three-quarters million sterling.

No materials seem to exist for determining the quantity of gold which at different periods has flowed from one continent to the other; but it is certain, that while the principal metal till 1525 was gold, the silver afterwards preponderated in the proportion of 60 or 65 to 1, until the commencement of the eighteenth century, when the Brazilian alluvial washings coming into work, the proportion was enormously changed; for while the silver-mines yielded about the same as before, the gold increased so as to alter the mean annual average supply of the precious metal from three

and a half to more than seven and a half millions. Towards the close of the eighteenth century the gold supplies began to fail, and those of silver to increase, the general result seeming to show that the proportion was reduced from 60 to 1 to 22 to 1, although it afterwards rose to nearly 40 to 1, and again sunk to 30 to 1. These very considerable fluctuations seem to have produced a comparatively trifling result, so far as the use of the precious metals in coinage gives evidence of such result; but the real amount of change,—if estimated in the proportion of the difference to the total amount of specie,—and the mean annual supply, will be seen to be very large. We ought not however to be astonished, as Humboldt well observes*, that "the proportion between the respective values of gold and silver has not always varied in a very sensible manner, according as one of these may have preponderated in the mass of metal imported from America into Europe. The accumulation of silver appears to have produced its whole effect anterior to the year 1650, when the proportion of gold and silver was as 1 to 15. Since that period the population and commercial relations of Europe have experienced such a considerable increase, that the variations in the value of the precious metals have depended on a great number of combined

* Political Essay, *ante cit.* book iv. chapter xi.

causes, and especially on the exportation of silver to the East Indies and China and its consumption in plate.

"If also Europe, at the commencement of the present century, produced, according to Monsieur de Villefosse, forty ounces of silver for one of gold, it appears on the other hand that in the 15th and 16th centuries the proportion was more in favour of the silver, since during that period the silver-mines were much more productive than the gold-washings, so that probably the value of gold must have risen in Europe even without the discovery of America." Within the last quarter of a century the supply of gold has greatly exceeded the supply on record for any former period, at length reaching to the value of more than six millions per annum, while the value of silver, although slowly increasing, has probably not exceeded eight millions.

But we must consider somewhat more in detail the statistics of the precious metals within the last fifty years, and the increase made to the stock of the precious metals within that period, so as to determine, as far as possible, the present amount of capital stock. It is only thus that we can estimate the influence of any sudden and considerable increase in the supply.

The following account (Table I.) will give the

probable annual supply at present, without including California, but making an ample allowance for the quantity which, there seems no reason to doubt, may be expected from Siberia.

TABLE I. *showing the present supply of gold and the sources of the supply.*

Europe, excluding Russia	£ 200,000
Siberia	4,000,000
Asia, excluding Siberia	500,000
Africa	400,000
North America	200,000
South America	1,200,000
	£6,500,000

The subjoined table (II.) gives the probable supply at the commencement of the present century.

TABLE II. *A comparative statement of the gold annually produced by Europe, Northern Asia, and South America in the beginning of the* 19*th century.*

Europe		£185,020
Northern Asia		76,770
New Spain	£229,630	
New Grenada	672,500	
Peru	111,530	
Potosi and the provinces to the east of the Andes, formerly included in the vice-royalty of Buenos Ayres	72,180	
Chile	400,550	
Brazil	980,870	
		2,467,260
Total		£2,729,050

The produce, on the average of the last few years,

may therefore be assumed as not less than four millions annually, and for the preceding forty years we may consider that it reached at least two millions and three-quarters, so that the total amount for the half century may be estimated as follows:—

8 years at £4,000,000	£ 32,000,000
40 years at 2,750,000	110,000,000
	£142,000,000

It now appears that the addition of three hundred and fifty millions sterling in gold from America alone, during three centuries, accompanied by great, sudden, and frequent changes in the relative quantity of gold and silver introduced, acting upon a capital stock of not more than a hundred and fifty millions, was needed to produce the effects on currency and on the price of labour already referred to. But it also appears that the quantity added within the last half century, amounting to much more than a third of that amount, has scarcely produced any marked result, or affected either the price of goods or the relative value of the precious metals. It is evident therefore that a very large increase indeed,—even in comparison with the additional three or four millions sterling unexpectedly thrown into the market within the last few years from Siberia, and which may no doubt be continued,—would be required to produce any marked result

that should require a modification of the standards of gold and silver in England.

Now let us consider how much of the capital stock of gold and silver, or the annual increment to that stock, is disposed of in successive years, and what proportion of it enters into circulation as coined money. It was supposed by Forbonnais that between the time of the discovery of America and the year 1724, one half the precious metals had been absorbed by the Indian and Levant trade, and one-fourth or half the remainder used in plate, or lost in melting, or by manufacture into trinkets; and M. Gerboux, who endeavoured to verify and extend the calculations of Forbonnais, considers that the actual specie in circulation in Europe in 1766, and some years afterwards, amounted to upwards of four hundred millions sterling; but this estimate is probably too high. However this may be, the loss by trade and absorption by the Indian trade has been gradually diminishing, the manufactures of Great Britain being now considerably more valuable than the produce imported from those countries. For many years past, therefore, the principal deductions to be made from the increasing stock of gold, would be from the loss by wear and the uses of this metal in the arts. We are not aware of any data that will aid us in calculating the amount of this deduction,

but the uses of gold are numerous, and the quantity required for various purposes very large.

In 1810, it appeared, from calculations made from the returns to government of the quantity paying duty, that the quantity of gold wrought in France by goldsmiths amounted to 7138 pounds weight avoirdupois, worth nearly £450,000. If this was the case during the time when the maritime war prevented importation, and in one country of Europe, it may well be imagined that the total consumption of gold in this way in the whole continent must have been very large. If we estimated it at two millions sterling at that time, it would probably be below the mark. No doubt a part of this supply was obtained from old plate, but there must still have been required an enormous amount of the precious metal to be taken out of the annual supply from mines. We must now add to this amount the quantity of gold used in gilding, and in other ways not paying duty, and also the increase in consumption during thirty years of peace and luxury.

The quantity of silver paying duty in the same year in France was about 176,500 pounds weight, value about £700,000*.

It is probable, therefore, that any very considerable increase in the amount of gold within certain

* Humboldt, *ante cit.* Supplement.

mits would be readily applied in various useful ways, while on the other hand, a large, though not perhaps an important quantity of the present supply would be withheld, owing to the cost of extraction not leaving a fair profit on the capital employed.

The gradual hoarding of the precious metals the different countries of Europe must also affect to a very considerable extent the actual quantity of gold in circulation, but it does not seem to have had any influence upon the ratio, and has, perhaps, even assisted in diminishing the fluctuations. Many years ago, it appeared that the annual supply of both the precious metals together did not exceed one per cent. upon the whole amount of capital represented in that form.

Humboldt, to whose 'Political Essay on New Spain' we have already so frequently adverted, says, in reference to the question which we are now chiefly concerned in discussing,—namely, whether the interests of society would really suffer from a considerable accumulation of specie,—"It is sufficient to observe, that the danger is not so great as it appears on a first view, because the quantity of commodities which enter into commerce, and which require to be represented, increases with the number of representative signs. The price of grain, it is true, has tripled since the

treasures of the New continent were poured into the Old. This rise, which was not felt till the middle of the 16th century, took place suddenly between 1570 and 1595, when the silver of Potosi, Porco, Tasco, Zacatecas and Pachuca, began to flow throughout all parts of Europe. But between that memorable period in the history of commerce and 1636, the discovery of the mines of America produced its whole effect on the value of money. The price of grain has not in reality risen to the present day; and if the contrary has been advanced by several authors, it is from their having confounded the nominal value of coin with the true proportion between money and commodities.

"Whatever opinion may be adopted as to the future effects of the accumulation of the representative signs, if we consider the people of New Spain under the relation of their commercial connections with Europe, it cannot be denied that in the present state of things, the abundance of the precious metals has a powerful influence on the national prosperity. It is from this abundance that America is enabled to pay in specie the produce of foreign industry, and to share in the enjoyments of the most civilized nations of the Old continent. Notwithstanding this real advantage, it is to be sincerely wished that the Mexicans, enlightened as to their true interest, may recollect,

that the only capital of which the value increases with time, consists in the produce of agriculture, and that nominal wealth becomes illusory whenever a nation does not possess those raw materials which serve for the subsistence of man, or as employment for his industry*."

We have endeavoured in the present chapter to illustrate and prove, as far as the subject admits of proof, several important matters, the heads of which we shall now briefly recapitulate:—

In the first place, we have shown that the absolute and relative quantities of the precious metals bear no necessary relation to each other; or, in other words, that a large increase or diminution in the annual supply of one or the other, even for some time, affects only in a comparatively small degree their relative value.

In the next place, that even when the quantity of the precious metals in Europe was enormously less than at present—probably not more than one-tenth part—the increase that took place on the discovery of America, amounting ultimately to the extent of tripling the amount of money given for the absolute necessaries of life (corn and meat), only at one period perceptibly altered the value of money; producing its effect for the most part

* Political Essay, vol. iii. p. 452–454. [Black's Transl.]

so gradually as not to interfere with the ordinary operations of commerce.

Thirdly, it appears that even should there be a very much greater increase in the total quantity of gold supplied than has ever yet taken place,—as for example, if the quantity should be doubled for several years to come,—yet this large increase must now be made to act upon so very large a capital stock already accumulated, as not to be likely to produce any immediate effect.

It also seems, that whatever the supplies of the precious metals have been, only a part, and even a very small part, has, at any time, entered into the circulation of Europe. It would appear that a certain absolute quantity is needed, to restore the loss by wear and hoarding in coined money, and that this and the additional quantity called for by the increase of commerce to represent additional values, was all that really came into the market, so far as the circulation was concerned. The rest has been found useful in manufactures and for plate and jewels, or has been taken by other countries, where it has perhaps been hoarded, and is thus lost sight of. Very little effect seems to have been produced by the enormous fluctuations that have from time to time taken place in the annual supplies of gold and silver, or either of them.

Judging by the supplies which have been introduced within the last few years from Siberia, and the effect hitherto, it is clear that the fears of those who anticipate a rapid and considerable change in the market values of gold and silver are unreasonable and unfounded. At the same time it ought not to be forgotten, that the causes formerly in operation, tending to carry away large quantities of these metals into the East, have been gradually ceasing to act for a long time, and that we now depend, and have been for some time depending, on the actual demand for them in the arts, and the increased capital expended in the luxuries of gold and silver plate (including under this head watches and jewellery). The accumulations of the precious metals in the houses of the middle and upper classes cannot by any possibility be estimated; but that the stock of such luxuries rapidly increases with the increasing wealth pouring into a country, is certain from many other causes besides the total disappearance of so large a quantity. The steadiness in the price of the metals themselves, not only where their value may be considered as regulated by law, but also in countries where they are more openly marketable at prices regulated almost entirely by the demand, is additional proof of the truth of this position.

It may be observed, that we have not estimated

any particular quantity as likely to be introduced annually from California. What evidence there is on this subject we shall consider in the next chapter, but it is very small in amount, and of very little value. That all estimates hitherto made are hypothetical, there cannot be the smallest doubt, and we believe that nothing like the quantities assumed will be obtained, at least for some time, even if the quantity of auriferous alluvium is as large, and the produce as rich, as is expected*.

If however we are mistaken, and if the large quantity of 100,000 lbs. weight avoirdupois of standard gold per annum (or the value of about £5,500,000 sterling at present prices) should by any possibility be raised from these alluvial sands, which, as far as they are at present known to be auriferous, are confined to a few small streams and an area certainly of a few hundred square miles of country, the effect produced would be after all only that of an average addition of less than one per cent. per annum, calculated upon the whole stock of gold existing in the world. We may venture to assert, without much fear of contra-

* The last accounts from America (Jan. 23) state that as much as 100,000 dollars' worth per month was then *supposed to be* the rate of supply. We may safely refer a large proportion of this to exaggeration.

diction, that the additional quantity would be to a large extent absorbed and taken out of circulation very rapidly, and that what remained would not for many years tell upon the coinage so far as to affect the standard values of gold and silver in Great Britain.

By the time that this change begins to be felt, it is quite certain that the alluvial deposits, if so rapidly worked, must be showing symptoms of exhaustion, for such deposits are neither inexhaustible nor are they rapidly recruited; and the mines that succeed, vaunted as they now are, will be found to resemble other mining operations, and can by no means be expected to yield continuously large supplies without great labour, risk and expense.

In point of fact, there is no reason whatever to fear that the quantity of the precious metals, or either of them, will multiply greatly beyond the demand, or that they will become much deteriorated in value. On this subject again we have the opinion of the author of the 'Wealth of Nations' to back our own, and with one more quotation from his work we shall close the present chapter:—

"The quantity of brass and iron annually brought from the mine to the market is out of all proportion greater than that of gold and silver. We do not, however, upon this account imagine

that those coarse metals are likely to multiply beyond the demand, or to become gradually cheaper and cheaper. Why should we imagine that the precious metals are likely to do so? The coarse metals indeed, though harder, are put to much harder uses, and as they are of less value, less care is employed in their preservation. The precious metals however are not necessarily immortal any more than they, but are liable too to be lost, wasted and consumed in a great variety of ways. The price of all metals, though liable to slow and gradual variations, varies less from year to year than that of almost any other part of the rude produce of land, and the price of the precious metals is even less liable to sudden variation than that of the coarse ones. The durableness of metals is the foundation of this extraordinary steadiness of price. The corn which was brought to market last year will be all, or almost all, consumed long before the end of the year. But some part of the iron which was brought from the mine two or three hundred years ago may be still in use, and perhaps some part of the gold which was brought from it two or three thousand years ago. The different masses of corn which in different years must supply the consumption of the world will always be nearly in proportion to the respective produce of those different years. But the pro-

portion between the different masses of iron which may be used in two different years will be very little affected by any accidental difference in the produce of the iron-mines of those two years, and the proportion between the masses of gold will be still less affected by any such difference in the produce of the gold-mines. Though the produce of the greater part of metallic mines therefore varies perhaps still more from year to year than that of the greater part of corn-fields, those variations have not the same effect upon the price of the one species of commodities as upon that of the other*."

* Smith's Wealth of Nations, book i. chap. xi.

CHAPTER IX.

THE PROSPECTS OF CALIFORNIA AS A GOLD-PRODUCING COUNTRY.

We propose now, in bringing this work to a conclusion, to offer a few remarks on several inquiries of considerable importance that naturally suggest themselves, and on the accurate reply to which must depend our views of the present and future value of California as a place of settlement and emigration, and a great mining district for the precious metals. Many of the facts and statements bearing upon these inquiries have already been presented to the reader in former chapters; but many of them, and perhaps the most important, are not yet communicated to Europe. There is however a great deal of available information, and we may perhaps be able to offer some general conclusions that will be useful.

The first question that seems to need attention is, how far the deposit containing gold may possibly extend, and what are the absolute limits of the area that has at present been determined to be auriferous. It is true that the information on this subject is exceedingly vague, but it must be

remembered that the florid accounts and enormous anticipations are founded on this information, whatever it is; for the assumption that the whole country or an extended valley with its numerous feeders contains auriferous detritus because two or three small streams have been found to do so, is far too unreasonable to be worthy of refutation.

The simple facts as to prospects of quantity seem to be reducible to three groups: first, those concerning the extent of the districts actually proved to be auriferous, and the yield of the deposit in gold on a fair average in those spots; secondly, the probable extension of those districts into other valleys lower down the same streams; for these also offer a reasonable prospect of containing auriferous alluvia, although the quantity will be smaller in proportion, and the labour of extraction more considerable than has been the case for the tributary valleys nearer the source of riches; and thirdly, the prospects of discovering the mineral veins from which these stores of gold were derived, and which it may be expected have not been exhausted. That the rivers of the Sacramento and San Joaquin receive many tributary streams running over auriferous gravel, besides those already proved to do so, may be very probable; but these must be tried, and such trials will often prove failures.

First, then, we take the prospects as deducible from the actual extent of ground proved, and the value of the contents when obtained. It seems that the only streams from which any quantity of gold has yet been derived are the American, the Feather and the Consumnes rivers, and the Sacramento, so far as it runs beyond the junction of the northernmost of these streams to its delta. The whole length of these river-courses, measured in direct lines, may amount to 250 miles.

But it must not be supposed that the gold is equally distributed over all this distance. It is no doubt collected in hollows and richer places, occurring only at intervals; and it may be worth knowing that these are by no means necessarily confined to the present level of the river, but may exist at several inches or even feet above the highest level of ordinary floods. Thus it may be considered that there is a tract of country not less than 250 miles in length, and of unknown but not great breadth *, any part of which may contain gold mixed with its gravel and soil, such soil extending to a depth which exceeds in every case hitherto mentioned two or three feet.

We have next to consider the quantity thus

* "At present the workmen are employed within ten or twenty yards of the river, that they may be convenient to the water."—*Mr. Larkin's Despatch to Mr. Buchanan.*

contained, and here again there is great exaggeration, but great real promise. Hitherto the washings have been conducted in places where the yield has been very large, and as it is not mentioned that selections have been made for the place of work, the whole of every valley and gully has been assumed to contain gold. But in many cases the actual bed of the river has been searched, and here the gold has been found abundantly. In other places good fortune or superior knowledge has made one district yield, or one set of men obtain, a far larger supply than others, as in a case already quoted, where the quantity obtained by one of two brothers working together for a day amounted in value to eighty-two dollars, while the other obtained only seven dollars. We are told, "There were two reasons for this difference; one man worked less hours than the other, and *by chance had ground less impregnated with gold.*" We leave our readers to judge which was likely to be the most important reason when gold was the object of search.

The nature of the gold obtained will be understood best by the following extract from an official statement issued from the Mint of the United States, and fully confirmed by private letters, which speak indeed of the pieces of gold being of extraordinary size, but add, "the largest weighing half

an ounce." All the gold hitherto obtained has been from washings, and although lumps weighing several pounds have been found, these are quite the exceptions, and probably do not even occur in the richest part of the district.

The official report alluded to has reference to gold received from the scene of action, partly obtained by purchase, and partly raised by the goverument officers. We are told that the quantity received "weighed 1804·54 ounces troy, of which 1423·80 was from the lower surface mines, and 380·19 from those at Feather river. On the 9th instant another deposit was sent by the Secretary of War, which weighed 228 ounces. The gold was of two sorts, though apparently not different as to quality. The first, from the 'dry diggings,' was in grains which averaged from one to two pennyweights; the other variety, from the swamps or margins of the streams, being in small, flat spangles, of which, on an average, it would take six or seven to weigh one grain. Of these by far the larger part of the deposits was composed."

The number of persons employed in washing was stated by Mr. Larkin, on the 28th June last, to amount probably to 1000; but in an account given in a newspaper, dated 14th August, we are told that it had reached 3000, including Indians. The whole of the newspaper statement however

bears marks of rather too much excitement on the subject to be altogether trustworthy. But even if we allow that there are 3000 persons employed, and that they raise on an average an ounce of gold daily each (value £4 sterling),—a very handsome allowance for so large a number,—the rate of supply would appear to be equal to about 68,000 pounds weight per annum, worth about four millions sterling. We are very safe in asserting that nothing like so large a sum will have been obtained even in the course of the first year's working, unless the reality is far better than the prospect; and we are equally sure that a very few years indeed at that rate would require an army of thirty rather than three thousand men, and ten years instead of one to produce the same amount.

The next class of facts that we have to consider is with regard to any increase in the number of gold-producing valleys, and the area of country containing auriferous detritus. There is no doubt much promise of this kind, partly from the nature of the country, so far as we know it at present from the description of travellers, partly from the nature of the case generally. Gold-producing districts, and the mountains in which auriferous veins occur, are rarely limited to small areas, and the general structure of the mountain-range of the Sierra Nevada, which perhaps represents the

most important of the ranges in continuation of the Andes of Mexico, would certainly render probable the existence of a considerable tract over which similar repositories exist. The denudation to which the presence of the gold alluvia is due has no doubt been widely acting, and has affected to a greater or less extent the whole of those streams running down the west slope of the snowy mountains to the river Sacramento.

We are told also of gold-washings in the country to the south, near the Tule lakes, and may anticipate discoveries in several—perhaps all the principal tributaries of the Joaquin as well as the Sacramento. How far the supply of gold will be sufficient to pay the cost of working in many of these is however doubtful. Some of them perhaps will be found valuable, but others will contain too little of the precious metal to be of much importance.

The lower part of the Sacramento river appears to terminate in a delta. The mud of this delta will certainly be found to contain gold, but the proportion is not likely to be very large. When washed and sifted by the stream, and left at the upper extremities of mud-banks, or the heads of islands up-stream, the gold will be obtainable, but the proportion will be small. Still the value of such auriferous mud will long continue, and receive constant additions after heavy floods.

The third prospect for California has reference to mineral veins; and with regard to this subject again, the brightness of present prospects is not likely to be realized by the future. Mineral veins containing gold will no doubt be found hereafter in the Sierra Nevada, and quantities—perhaps large quantities of gold will be thence obtained. But these veins will not give up their riches without severe labour, heavy expense, and careful and scientific management. Gold is not, and never will be, dug out of the earth by spadesfull. Such ideas are the wild speculations of the thoughtless and ignorant, and are not based on any observation or any knowledge of what either has been or is likely to be. The prospects of California, as a mining district, depend, after all, much more on the way in which human labour and human intelligence are applied, than upon casual and local supplies of the precious metals, although these may be equal or superior in amount to those afforded by any other country in the world. A very short time will serve to calm down the fever of excitement that at present exists; and in California, as everywhere else, the hard-working, steady and honest will succeed and become rich and prosperous, whether he find gold in the soil, or whether his diggings yield him crops that he can turn into gold; while the idle and dissipated, who are now perhaps

raising many pounds weight of gold per month, by the accidents of gold-finding, will readily part with his riches, so easily acquired, and fall back into his former condition, whatever that may have been.

It is not easy to estimate the possible influence of the large quantities of gold recently obtained, upon the peopling of California by settlers and emigrants. Much of this will depend on the value of the country for settlements, and we have already stated that in this respect the district is sufficiently favourable. As one main element, then, in the future prosperity of California, we may discuss, in the second place, how far it is a country adapted to the ordinary requirements of civilized man, and especially of the Anglo-Saxon race, whether of this or the other side of the Atlantic.

Much of the information required to decide this point has been already given, and it thence appears that as far as climate, productions, extent, political and commercial position, and association with any native tribes, are concerned in rendering a spot fit for emigration, Upper California is at least as highly favoured as any other part of the Pacific coast of America. There are not wanting also other advantages well-worthy of careful attention, and amongst them the vicinity of Vancouver's

Island, which would seem to possess large supplies of good coal. This may be of the greatest importance in producing speedy and convenient steam communication with that part of the coast of Mexico where the Isthmus of Panama can be most conveniently crossed. At the present moment the journey across this neck of land is troublesome and dangerous, but either a railroad or a canal must very soon be constructed to render this more rapid and secure. This done, and the Pacific coast of America connected with the Atlantic coast by ready means of transit, no check would be likely to occur to the rapid development of the resources given by nature to the country of Upper California, of which perhaps one of the least advantages (though leading to the rest) is the presence of an unusual proportion of gold.

The immediately adjacent country of Oregon yields at present abundance of flour, salmon, and cheese; and the Sandwich Islands (within a few days' steaming) provide sugar, coffee, and tropical fruits. Hitherto California has chiefly supplied hides and tallow in exchange for these and the few other articles imported; but now its gold will attract such necessaries and luxuries, together with many others hitherto not introduced. England may now furnish its cottons, and other articles of clothing, its tools and implements of iron,

and obtain in return the metal so much prized. In spite of its natural wealth and produce, this country has been, up to the present time, owing to its great distance from civilized lands, and the smallness of its trade, almost entirely without the necessaries of civilized life. The time has now come when these will be amply supplied, and therefore in this sense, and to a very remarkable degree, California offers prospects which may well induce emigrants to go out and establish themselves.

The value of a country may be considered to depend on fertility, climate, geographical position, and mineral wealth. To the first point we have alluded in the second chapter, but may now recapitulate what was there said, by quoting the additional evidence of Mr. Bryant:—"The soil of that portion of California between the Sierra Nevada and the Pacific will compare in point of fertility with any that I have seen elsewhere. Wheat, barley, and other small grains, with hemp, flax, and tobacco, can be produced in all the valleys without irrigation. To produce maize, potatoes, and other garden vegetables, irrigation is necessary (but water is not wanting). Oats and mustard grow spontaneously with such rankness as to be considered nuisances upon the soil; I have forced my way through thousands of acres of these, higher than my head when mounted on a horse. The

oats grow to the summits of the hills, but they are not here so rank and tall as in the valleys. The varieties of grasses are greater than on the Atlantic side of the continent, and far more nutritious. I have seen seven different kinds of clover, several of them in a dry state, depositing a seed upon the ground so abundant as to cover it, which is lapped up by the cattle and horses and other animals, as corn and oats when threshed would be with us. All the grasses, and they cover the entire country, are heavily seeded, and when ripe are as fattening to stock as the grains which we feed to our beef, horses, and hogs. Hence it is unnecessary to the sustenance or fattening of stock to raise corn for their consumption. The crops of wheat and barley which I saw about the 1st of June, while passing through the country on my journey to the United States, exceeded in promise any which I have seen in the United States. Nearly all the fruits of the temperate and tropical climates are produced in perfection in California*."

The climate is no less distinctly reported on by the same authority, who has spoken at the same time of its agreeableness and salubrity. He says, "It is rarely so cold in the settled portions of California as to congeal water. But twice only while

* "What I saw in California."

here I saw ice, and then no thicker than window-glass. I saw no snow resting on the ground. The annual rains commence in November, and continue with intervals of pleasant spring-like weather until May. From May to November usually no rain falls. There are however exceptions, as rain sometimes falls in August. The thermometer at any season of the year rarely sinks below 50°, or rises above 80°. In certain positions on the coast, and especially at San Francisco, the winds rise diurnally, and blowing fresh upon the shore, render the temperature cool in midsummer. In the winter the wind blows from the land, and the temperature at these points is warmer. These local peculiarities of climate are not descriptive of the general climate of the interior. For salubrity, I do not think there is any climate in the world superior to that of the coast of California. I was in the country nearly a year, exposed much of the time to great hardships and privations, sleeping for the most part in the open air, and I never felt while there the first pang of disease or the slightest indication of bad health. On some portions of the Sacramento and San Joaquin rivers, where vegetation is rank and decays in the autumn, the malaria produces chills and fever, but generally the attacks are slight and yield easily to medicine. The atmosphere is so

pure and preservative along the coast, that I never saw putrefied flesh, although I have seen in mid-summer dead carcases lying exposed to the sun and weather for months; they emitted no offensive smell. There is but little disease in the country arising from the climate."

In geographical position also, especially as regards San Francisco and the valley of the Sacramento, the evidence is equally satisfactory; and as all the evidence on the subject agrees, and has yet been derived from very different sources, we may fairly suppose that it is to be depended on. Mr. Bryant says, "The entrance from the ocean into the bay is about a mile and a half in breadth. The water at the entrance and inside is of a sufficient depth to admit the largest ship that was ever constructed; and so completely land-locked and protected from the winds is the harbour, that vessels can ride at anchor in perfect safety in all kinds of weather. The capacity of the harbour is sufficient for the accommodation of all the navies of the world. The town of San Francisco is situated on the south side of the entrance, fronting on the bay, and about six miles from the ocean. The flow and ebb of the tide are sufficient to bring a vessel to the anchorage in front of the town, and to carry it outside without the aid of wind, or even against an unfavourable

wind. A more approachable harbour, or one of greater security, is unknown to navigators."

We come lastly to the mineral wealth. At the time of Mr. Bryant's visit and residence in California, the gold-region of the Sacramento had not been discovered. He merely says—"While in California I saw quicksilver, silver, lead and iron ores, and the specimens where taken from mines. From good authority I learned the existence of gold and copper-mines, the metals being combined; and I saw specimens of coal taken from two or three different points, but I do not know what the indications were as to quality. Brimstone, saltpetre, muriate and carbonate of soda, and bitumen are abundant."

Since this was written, the abundant produce of the gold alluvial washings has completely withdrawn attention from any other substances; but judging from analogy, and from other gold districts, especially in America, it is most likely that silver will ultimately become a very important addition to the mineral wealth. No good qualitative analysis of the gold has yet been made, to determine whether the amount of alloy is silver, platinum or palladium, or any of the rarer metals occasionally mixed with gold, but it is highly probable that some of these exist. The quicksilver alluded to by Mr. Bryant has already been shown

to be of great value; but of the other metals, copper, lead and iron, we have heard nothing, nor is it at all probable that the coal will prove of value. The various volcanic products alluded to are probably from some of those spots where volcanic agency has not yet ceased to exhibit its effects on the surface.

It is now necessary to say something with regard to the position of San Francisco, the port of California, and its accessibility. The town itself, which appears to have been very rapidly increasing under the United States government, even before the discovery of the gold, is, as we have mentioned above, about six miles from the sea. In September 1846 the population was only between one and two hundred, but in June 1847 it had increased to twelve hundred, and is now no doubt much greater. The town is about fifty-five miles in a direct line from the point where the Sacramento and San Joaquin rivers enter the bay at the same point, and the gold region commences about twenty miles up the delta of the Sacramento.

At present there is steam communication established between San Francisco and Panama, the distance being 3500 miles, the time of transit about twenty days, and something like regular voyages being made. From Panama, across the isthmus bearing that name, to Chagres on the

Atlantic side, the distance is not more than fifty miles, and it is understood that with money the passage may be made in two days. Under present circumstances, and with an unusually large number of persons travelling, the difficulties might be considerable. The West Indian steamers offer a ready mode of conveyance to and from Chagres and the various ports in the world, ports from which regular and frequent communication is made. Notwithstanding however that this mode of reaching the golden land is so much shorter in point of distance, the journey round Cape Horn, which would occupy about five or six months, might probably be in fact the shortest in point of time and the best. No other route is really practicable and safe besides these two. It is understood that the charge of conveyance from Chagres to Panama, and so to San Francisco, would not exceed 270 dollars, or something less than £60 for each passenger. Ships are advertised to convey passengers from London to San Francisco at the uniform rate of £25 each, carrying only one description of passengers.

There is then opened to us now in America, in a country which has recently fallen into the hands of a race certainly as much inclined to make the most of natural advantages as any people in the world, a district which may equal, or even surpass,

the richest of those worked for the precious metals. But the gold which in Siberia is kept back, or hoarded by the Imperial avarice or foresight, and which there is probably regarded as chiefly available for war—or which in Brazil has only gradually been brought into circulation, owing to the want of physical energy in the people, will now be employed in a different mode, and will in a short time find its way into the great markets of the world. In proportion as the mines are worked more rapidly, so will the district the sooner fall back into what may be called its natural position; but we may fairly expect that one great result of this discovery will be the laying open and rendering available much sooner than could have been done in any other way, the great resources of the Pacific side of America. This side, superior in climate and fertility to the other, and quite equal to it in commercial position for many important departments of trade, will now, at least, have justice done it. The Pacific will be covered with the ships of the world as the Atlantic and the Indian Ocean have long been, and our own Australian possessions, placed midway between spots so distant, will not fail to profit by the enlargement of a trade so important. Fleets of steamers will soon navigate the intermediate ocean, and touch

at shores which, till now, have rarely seen any white men, except those of Spanish blood; and in the course of a short time, the true value of the various possessions in the Oregon territory, Vancouver's Island and elsewhere, which have been too long neglected, will be felt and appreciated.

These are the favourable results that may be reasonably anticipated from the recent discoveries in California; and if to attain these benefits there is at first a little difficulty, and even some suffering and misery, it must be remembered that no important good can be had without such drawbacks, and that the advantage will be permanent, while the evil is very temporary. We hail, therefore, the discovery of gold in California as a great benefit, not only to the district and the country to whose territory it now belongs, but also to the whole world, and more especially to England, which will not fail to supply those objects of manufacture of which she has such an abundant quantity always at hand, ready to pour into any market that may present itself.

THE END.

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